SCIENTIFIC AMERICAN

No. SUPPLEMENT, 314

Scientific American Supplement. Vol. XIII., No. 314. Scientific American established 1845. NEW YORK, JANUARY 7, 1882. Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.

THE TEMPLE OF THE SUN, BAALBEK.

THE City of Baal, or the God of the Sun, known by the Romans and Grecians as Heliopolis (City of Helios, City of the Sun), was situated in Cœle-Syria, and contained a grand temple of Bel Helios, probably built during the reign of Severus and Caracalla (193–217 A.D.), in which temple the art of the Romans is combined with the pompous Asian luxury. The present village of Baalbek (in the Eyalet Akka of Turkey in Asia, at the foot of the Anti-Lebanon, on the slope of the hills in the valley of El-Bekka), of 500–600 inhabitants, and governed by a special emir, contains all the wonderful ruins of ancient Baalbek, which are classed among the grandest ruins of Asia Minor. Of these ruins, the grandest are those of the great sun temple, which consisted, besides the temple proper, of two large anterior courts, surrounded by rows of columns and passages, provided with an elegant portico. The temple proper, in the rear part of the second and larger court, consisted of a quadrangle, 146 feet wide and 208 feet long, the roof of which was supported by a peristyle of 54 Corinthian columns, but only six are standing now. All the rest are broken, and the temple is now situated in the most picturesque field of ruins in the world. The enormity of the stones is really wonderful, for some are 60 feet long and 12 feet thick. To the south of the main temple there is a smaller oblong temple, of which the cellar walls and the peristyle are quite well preserved. Both temples are similar to Grecian temples in the ground plan, and they and the courts are built of lime-stone and provided with the most pompous and luxuriant Roman ornamentation. All these enormous masses are united without mortar, and yet not a single fissure or crevice is visible. The examination and study of Baalbek's enormous ruins has led to the belief that the overloading with luxurious ornamentation and the changes of architectural proportion, which finally caused the ruins of antique architecture, originated in Baalbek and Palmyra at the same time. But the mixture of Oriental and Græco-Roman architecture is much more domineering in the ruins of Baalbek than at Palmyra, the other city of ruins in Syria, and the Oriental influence is most conspicuous in the third and smallest temple, located a short distance from the city.—*From "Palæstina," by Ebers and Guthe.*

[NATURE.]

JAMES CLERK MAXWELL.

Born June 13, 1831; *Died November* 5, 1879.

WE have already said so much on the life and work of the late Prof. Clerk Maxwell, that in presenting his portrait as one of our scientific worthies, little more is necessary than to refer to the leading facts of his life. Born on June 13, 1831, he was the son of John Clerk Maxwell, of Middlebie, a scion of a well-known Scottish family, the Clerks of Penicuick. When James was only eight years of age he lost his mother, after which his father led a retired life, devoting himself to the care of his estates and of his son. The latter was educated in the first instance at the Edinburgh Academy, where in 1845 he gained the Academical Club Medal for Geometry, and the Silver Medal for Mathematics in 1847. A visit to William Nicol at this period was a marked event in his life, leading him, with apparatus of his own construction, to make observations on polarized light. A pair of prisms presented to him by Nicol were treasured by him throughout life, and three weeks before his death they were deposited in one of the show-cases of the Cavendish Laboratory.

JAMES CLERK MAXWELL.

After leaving the academy, Maxwell, to quote the words of Prof. Tait, "spent the years 1847–50 at the University of Edinburgh, without keeping the regular course for a degree. He was allowed to work during this period, without assistance or supervision, in the laboratories of natural philosophy and of chemistry; and he thus experimentally taught himself much which other men have to learn with great difficulty from lectures or books. His reading was very extensive. The records of the university library show that he carried home for study, during these years, such books as Fourier's 'Théorie de la Chaleur,' Monge's 'Géométrie Descriptive,' Newton's 'Optics,' Willis' 'Principles of Mechanism,' Cauchy's 'Calcul Differentiel,' Taylor's 'Scientific Memoirs,' and others of a very high order. These were *read through*, not merely consulted." In October, 1850, Maxwell went to Cambridge, entering at Peterhouse. Soon after his entry at Peterhouse, however, in December, 1850, he migrated to Trinity, where he found spirits of tastes similar to his own in the matter of physical research; here he soon became a leader among his fellows. In 1854 he came out second wrangler, and was bracketed as First Smith's Prizeman. In 1855 Maxwell became a fellow of Trinity, and in 1856 he obtained the professorship of natural philosophy in Marischal College, Aberdeen. To quote the memoir by Mr. W. Garnett: "In 1858 he married Katherine, a daughter of Principal Dewar of Marischal College, thus vacating his fellowship at Trinity. In 1860 he succeeded Prof.

RUINS OF THE TEMPLE OF THE SUN, BAALBEK.

Goodeve as professor of natural philosophy and astronomy in King's College, London, but after the death of his father he retired, in 1865, to his estate in Scotland, where he subsequently carried out his father's plans for completing the house and offices at Glenlair. In 1871 he was invited by the Senate of the University of Cambridge to accept the chair of experimental physics which had just been created, and on October 25, 1871, he delivered his inaugural lecture as professor of experimental physics in the University of Cambridge. At first the most important part of his work consisted in arranging the details of the Cavendish Laboratory, which the Duke of Devonshire had offered to present to the University, and the building of which was personally superintended by Prof. Maxwell from first to last. The whole of the arrangements which render the Cavendish Laboratory so admirably adapted for physical investigations are due to the care and forethought of Prof. Clerk Maxwell. When the building had been completed and formally presented to the university, the Duke of Devonshire further signified his desire to provide it with a complete equipment of apparatus, and all this was procured under the personal supervision of the professor. In 1872 he was elected honorary fellow of Trinity College, Cambridge."

During the winter of 1878-79, Prof. Clerk Maxwell's health began to give way, and with some transient gleams of hope he gradually sank, dying on November 5, 1879. He received many honors during his lifetime; he was a Fellow of the Royal Society, LL.D. of Edinburgh, and D.C.L. of Oxford; Honorary Member of the American Academy of Arts and Sciences, the American Philosophical Society, and the New York Academy of Sciences, Corresponding Member of the Imperial Academy of Sciences, Vienna, and Associate of the Amsterdam Royal Academy of Sciences.

In 1860 the Rumford Medal of the Royal Society was awarded to Prof. Clerk Maxwell "for his Researches on the Composition of Colors, and other Optical Papers." In his address on the presentation of the medal, Major General Sabine alluded to Prof. Maxwell's calculation showing the connection of the "mecbanical strains to which elastic solids are subjected under certain conditions with the colored curves which those solids exhibit in polarized light."

To Clerk Maxwell's private character, to the position he unobtrusively took as a Christian, to his qualities as a poet and humorist, and to the varied work he has accomplished, it is scarcely necessary again to allude here; all these points will be found clearly brought out in the articles by Prof. Tait and Mr. Garnett above referred to. Nor is it necessary to repeat here the list of his principal papers and publications, and the great and important additions which Clerk Maxwell made to the sum of scientific knowledge, or the light he shed on the principles of the departments of science which he specially cultivated. Besides the references already given we would commend the reader who desires to have a fairly complete notion of the value of the work of the remarkable man whose portrait we give to-day, to the articles by Prof. Tait on Clerk Maxwell's "Electricity and Magnetism," vol. vii., p. 478; "Matter and Motion," vol. xvi., p. 119, and the numerous papers by Maxwell himself scattered through the volumes of *Nature*.

WHAT TO DO WHEN THE LOCOMOTIVE BREAKS DOWN.

By FRANK C. SMITH, M.E.

THE locomotive engineer who is "posted" knows or ought to know just what to take down and what to do when an accident occurs. Nothing is more galling to an engineer than to bring his engine in with the half of her on the tank, when one-fifth of the disconnection carried in that way would have answered better. The idea held by so many engineers, that the more of their engine they take down the more safely she can come in alone, is, of course, wrong, as each part so disconnected leaves some other part either better or worse off. The following suggestions may be of value in such emergencies:

When an engine gets off the track, the first thing to be done by the engineer, if he is not disabled, should be to pull his fire, if the position of the engine is such as to leave the crown-sheet or flues uncovered with water. If the ash-pan is jammed, or if from any other cause the fire cannot be pulled or dumped, it may be smothered by shoveling green sod, sand, earth, or snow into the fire-box. If the engine cannot be replaced without the help of another engine, the side and main rods should come down to prevent them from being sprung. If the engine is still on her wheels it will generally be found that she can be got back on the track more easily the way she came off. In case of a broken side-rod, disconnect the broken rod and the opposite side-rod also. This is all that is necessary. The necessity for taking down the opposite rod is that if only the broken rod is removed and the pin on that side is on either quarter, the pin on the opposite side being on the center cannot start the back drivers through its side-rod, should the forward drivers slip in starting; the result being that the back drivers, not being compelled to slip with the forward ones, would remain nearly stationary, the front pin would pass the center, shortening the distance between the pins, and the rod would bend or the pin break, necessarily.

If the main rod breaks, disconnect it; block the cross-head at the back end, disconnect the valve stem and tie it to the hand rail if it has a joint, and then go ahead. It would be as well, in connection with the above, to pull the valve clear back so as to open the front port, or cover both ports with the valve, jamming the gland on the stem by screwing up one side only.

The plan frequently adopted by engineers after taking down the main rod is to place the piston at the back end of the cylinder, open the front port, and jam the gland on to the stem to hold it in position. This plan is a poor one, as the valve may shift, and then a bad cylinder head is the result. Always block a piston or cross-head at the back end of the guides, for if the blocking should get loose, the front head, which is the cheaper, would alone suffer. A better plan than carrying blocking for the cross head is to have the blacksmith make a hook out of 1¼-inch round iron, also a flat piece or bar 15 inches long, 1¼ or 2 inches thick, and 4 inches wide, with a hole through its center for the shank of the hook to pass through—the shank being threaded for a nut. When it is necessary to block a piston, get it to the back end of the guides, pass the hook round the cross-head wrist and the shank through a hole in the other piece which rests against the face of the yoke supporting the back end of the guides, run up a nut on the shank of the hook hard against the bar, and the piston is secured. Two nuts are better than one, the outside one being jammed on to the other.

If a leading wrist-pin breaks, the main and side rods on that side and the side rod on the other side must come down, the piston must be blocked, and the valve stem disconnected. In case of the breaking of a back pin, both side-rods must come down.

If a valve stem breaks, take it down, also the main rod on that side, in the mean time blocking the piston. If the stem is broken outside of the chest, let the piece remain in the stuffing-box, fill in some packing, and screw up the gland.

If the back-up eccentric rod breaks, take both eccentric rods down on that side of the engine. If it is a go-ahead rod, it alone may come down with the straps, also the main rod and valve stem on that side. The main rod and valve stem should also be disconnected in the case of a broken back-up eccentric rod, and in either case the link should be disconnected from the tumbling-shaft by disconnecting the hanger.

If the lifter tumbling-shaft, arms, saddle-pin, or reach-rod breaks, a piece of wood may be fitted and tied in between the block and top of the link slot for the link to rest on. The piece should be long enough to raise the link to cut-off where the engine is desired to run.

In case of a broken reach-rod or tumbling-shaft, both links must be blocked up as described. As the engine will then have to be held entirely with the brake, great care will be necessary.

For broken eccentric straps or eccentrics, proceed as in case of eccentric rods. For a slipped eccentric—assuming it to be the go-ahead one, and the engine a link engine—put the engine on the center on the side of the slipped eccentric, pull the reverse lever into the full back up notch, mark the valve stem flush with the gland with a knife blade, throw the lever in the full go-ahead notch, turn the slipped eccentric till the mark on the stem reappears in the same position as when marked, notice that the slipped eccentric is not in the same position as the back-up eccentric, but the full part or belly nearly opposite, and then go ahead.

In the case of a broken spring hanger, the broken spring should be removed, unless an extra hanger or a chain is carried, in which case the end of the spring may be held by the new hanger or the chain, it being necessary to jack up the back part of the engine, under the foot-board, to take the weight off and allow the insertion of the hanger or chain. If neither hanger nor chain can be had, slip a block of wood or rubber under the end of the equalizer, thick enough to raise it about level, the weight being removed from it by jacks under the foot-board. If the engine has far to go, or has a train to pull, it will be best to put a block of wood over the driving-box, between it and the frame, and over the wheel where the hanger is broken, to ease the other spring. If jacks are not carried, the driver may be run on to a stick of wood 4 or 6 inches in thickness, placed under the forward wheel to take the weight from the back wheel, and *vice versa*.

A broken spring should be treated the same as a broken spring hanger.

A broken equalizer should be removed, as it may get into the wheels, also the springs and wooden pieces placed over the driving boxes to keep the frame up.

A broken tire, if clear off, requires the wheel center to be kept from the rail, either by running the wheel on to a block of wood, or by jacking up under the wrist-pin and fitting a piece of wood between the oil cellar and pedestal brace. The two side-rods should come down if the tire is a back or forward one, and also the main rod on that side. If the engine has far to go and a train to pull, it is better to remove the oil cellar and fit a notched piece of wood in its place to give a proper bearing for the shaft, as otherwise the shaft will rest on the thin edges of the oil box—a bearing entirely insufficient, if any distance is to be run, or a load pulled. The writer has seen engines brought in with broken tires and the shaft running on the oil cellars, the bearings being so badly cut as to make it necessary to remove the wheels, re-turn the bearings, and fit new driving box gibs or brasses.

It should be remembered that whenever the main rod is disconnected, the piston must be blocked and the valve stem disconnected.

A broken front truck wheel or axle can usually be chained up with the help of jacks under the front end, so as to get on a side track. The engine should be run very slow.

An unshipped throttle requires that the steam pressure be reduced, pulling the valve stem into the middle notch to shut off, and when taking water, the driving wheels to be blocked with sticks of wood when the tender is in the right position

A bursted flue can be plugged with a wooden plug, or, better still, with an iron one held in a pair of tongs or some special device for that purpose.

If a driving axle breaks so as to leave the wheels in position, the engine may generally be run alone on to a side track, and extra wheels and axles sent for.

A broken cylinder head requires that the main rod on that side should come down, and the ports covered by the valve and the valve stem disconnected.

If the steam chest or branch pipe in front end breaks, a piece of 2-inch plank with a rubber gasket beneath it should be bolted to the "nigger-head" or "T-head," the branch pipe being removed. The main rod should be disconnected on that side.

If the steam pipe breaks inside the boiler, the same means may be employed as for an unshipped throttle.

A broken flange on a truck wheel requires very slow running.

If a tender axle or wheel breaks, that end of the truck may be chained to a tie placed across the apron of the tender, blocking being placed between the tie and body of the tank to ease the strain on the apron. Both ends of the tie should be chained to the truck.

The above will cover the ordinary mishaps to which locomotives are liable, and which can be remedied by carrying out the suggestions recommended.—*National Car-Builder*.

MAGNETIC PURIFICATION OF PORCELAIN CLAY.

A PROMISING method of separating particles of iron from clay to be used in making porcelain, employs two powerful electro-magnets placed with opposite poles facing one another, and between them is a trough or funnel with a vent-hole in its lower part. The liquid clay is caused to flow along the sides of this trough, past the magnetic poles, which attract the iron to the sides. Twice a day the sides are cleansed of the deposited material. In this way half a ton of clay can be purified per day in each trough. The magnetic deposit is said to consist mainly of silicate of iron with a trace of carbon. It is claimed that the value of the clay is increased forty per cent. by this purification.

ADVANCE IN THE PRICE OF LOCOMOTIVES.

WHEN questioned by a representative of the *Telegram*, a gentleman, who is a very high authority in these matters, said:

"So great has been the advance in the price of locomotives that the Manhattan Beach Company the other day sold an engine for $9,000, the price paid for it two years ago last spring being only $5,000. All of their engines, which cost $5,000 each, they could readily sell to day for $8,000. The demand for engines is so great that the roads which can possibly dispose of engines—second-hand engines—obtain an advance of from $1,000 to $2,000 over the market price for future deliveries, on account of the advantage gained in their immediate use. Some of the largest orders placed are those for the Denver and Rio Grande, which road has ordered about two hundred and fifty engines within the last six months, the Baldwin Works receiving the greater number of orders.

"Four classes of locomotives are manufactured here—the eight-wheel or American type, the Mogul or six-wheel driver, the consolidation eight-wheel driver, and a class which is a modification of the consolidated, with only one pair of leading wheels. The cost of all these engines has advanced forty per cent. during the last two years. Taking into the estimate all these classes the average cost of a locomotive is now from $12,000 to $13,000. The price of the heaviest and most costly locomotive made here is about $18,000.

"The total of locomotive engines in this country is 12,700. It is a matter of great interest to note the allotment of these to the several grand divisions of States and then to the leading States of such divisions. Some men see no beauty in statistical tables, and to such it may be pointed out that the locomotive record this day, as made up by the hardest-headed statisticians for another purpose, notes accurately the position of each State or section in the matter of progress. Of this total of engines New England has 1,700. Massachusetts leads with 968. The Middle States have 6,000 locomotives. It will humble New Yorkers a little perhaps to know the exact truth, which places Pennsylvania as the leading State, with 2,700 railway motors; New York comes next with 2,000. The young Western States, born only yesterday, already overtop all other sections of the land in the number of railway engines, the aggregate being 7,800. Illinois leads with 1,900. The Pacific States have 420, California having 330. The Southern States have 1,800 locomotives, Georgia leading with 363, Virginia coming next with 300, and North Carolina and South Carolina following with 146 each. Florida's position is shown by the cold-blooded statistician's figures of 38 locomotives for that State large enough for an empire.

"Now, if it were possible, as with one stroke of the pen, to annihilate every locomotive in the country, and if it were possible at the same time to keep every locomotive building shop in full blast to supply the demand, these shops could not at their utmost turn out more than 2,300 locomotives during the ensuing year. The following includes all the locomotive works of this country, with an approximate statement of their annual capacity: The Baldwin, Philadelphia, 600 locomotives; the Brooks, Dunkirk, 120; Danforth, Paterson, 150; Dickson, Scranton, 100; Grant, Paterson, 120; Hinkley, Boston, 120; the Lima Machine Works, Lima, Ohio; Manchester, N. H., 100; Mason Machine Company, Taunton, Mass., 75; Pittsburg, 75; H. K. Porter & Co., Pittsburg, 75; Portland, Me., 250; Rhode Island Locomotive Works, Providence, 80; Risdon Iron and Locomotive Works, San Francisco; Wyoming Valley Company, Wilkesbarre; Schenectady Locomotive Works, 100; Rogers, Paterson, 175; Taunton Locomotive Works, 80. To these estimates should be added those of the products of the Canadian locomotive shops. These establishments are the Canadian Engine and Machine Works, Montreal; the Canadian Locomotive Company, Kingston; Canadian Locomotive and Engine Company, Montreal. Altogether their utmost annual capacity is probably only about 80 engines.

"So great is the pressure that no locomotive shop in this country could build a single engine, if ordered now, before August of next year without interfering with present orders. The Baldwin Locomotive Works of Philadelphia have already orders which will even cover the entire time up to March, 1883. The Rogers Works at Paterson on Friday last closed an order for 100 locomotives. In brief, the demand for railroad engines is far greater than the supply. By the way, this pressure of demand over supply in railroad operations is by no means confined to locomotive building. The car builders are quite as crowded. The contractors for steel rails are equally at their wits' end. From October of last year to October of this year there were orders for about 900,000 tons of steel rails; and yet if an order were given to-day for steel rails for one hundred miles of road the stock could not be delivered before next July. It would be hard, also, for the foreign manufacturers to fill orders before next March, and the duty on their rails would be $28 per ton. Here is another singular thing: The manufacturers of railroad machines and tools, used in various processes in the construction of locomotives, etc., cannot fill their orders. Bement & Sons, of Philadelphia, about the heaviest firm in this line in the country, will not be able to deliver a single machine outside of existing orders before 1883. Of course this matter largely governs everything else, for if the machines cannot be had the locomotives cannot be finished."

"To what do you mainly attribute this pressure upon the locomotive builders?"

"The great strain is on account of new roads. For instance, this year 8,000 miles of new roads and of extensions have been built. The Chicago, Milwaukee, and St. Paul Railroad ordered 150 engines last year."

"Has this great demand caused many orders to be sent abroad for locomotives?"

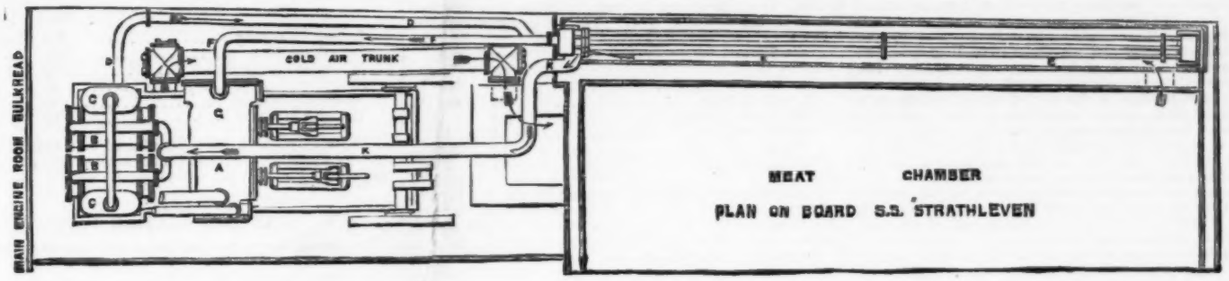
"Three or four months ago an order was given a firm in Yorkshire, England, for eight locomotives, as a trial. It is supposed that they are for the Pacific coast. The great difficulty about buying engines abroad is the duty. One road in this country is ready to offer for 100 foreign built engines so soon as this tariff question is settled. It is estimated that the average duty would be about fifty per cent, so that the eight light built engines I have mentioned, costing each about $8,000, would pay a duty of nearly $4,000 each. Strangely enough, in all our tariff revisions there is no provision for the locomotive. It is not in the tariff at all, and therefore the only way out of the difficulty is the paying of the rates on the various metals; so much for the steel in the locomotive, so much for the brass, etc. Sellers abroad will not take the risk of furnishing locomotives here, because this duty is such an unknown quantity, and buyers will not buy in the foreign market unless a price is named duty paid. But even if this difficulty were removed, the foreign manufacturers would, for this market, have to build locomotives after the American type. The American engines are superior to all others. The American roads will have none other than American engines."

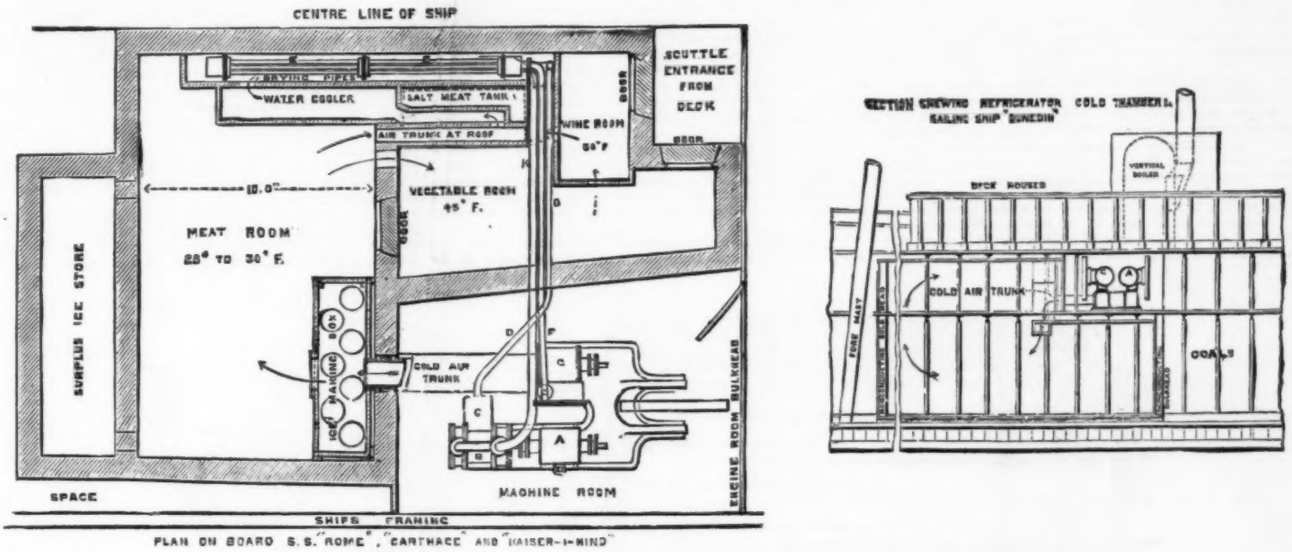
REFRIGERATING APPARATUS, S. S. STRATHLEVEN AND DUNEDIN.

WE illustrate below the machinery which was fitted on board the steamship Strathleven in September, 1879, by the Bell-Coleman Mechanical Refrigeration Company, Nile Street, Glasgow, under the personal superintendence of the managing partner, Mr. J. J. Coleman, and which brought the first cargo of frozen meat which arrived in England from the antipodes. This meat arrived in February, 1880, in excellent condition, the quantity being 33 tons, and it sold in Smithfield at good prices.

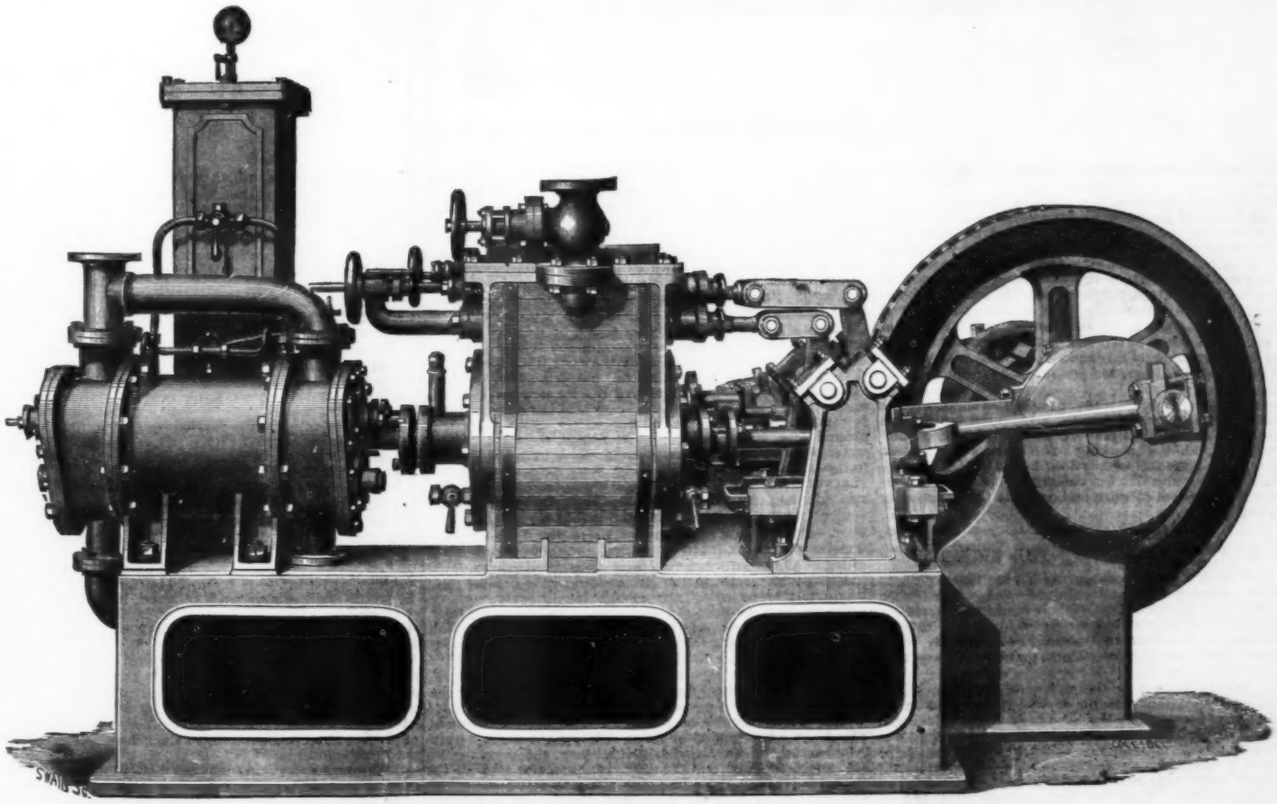
It has proved the pioneer of an important trade. This machine had a pair of air compressors, B B, of 16 in. diameter and 2 ft. stroke, in which the air was compressed by the steam cylinder, A. The great heat which would be generated by the dry compression of the air, and would greatly increase the power required to drive the machine, was in this case avoided by vigorous injection of water during the act of compression, and the tepid compressed air passed to the water tower, C, where it was brought into intimate contact with the water spray and reduced almost to the temperature of the spray. The compressed air then passed by the pipe, D, to the system of drying pipes, E E, which were simply a set of tubes placed in the waste air current on its road from the chamber back to the machine, and thus the compressed air inside the tubes was cooled to a lower temperature than that attained by the use of the sea water, and consequently deposited aqueous vapor which was removed by automatic traps not shown in the drawing. The compressed air thus deprived of moisture passed by the pipes, E, to the expansion cylinder, G, where in contributing to the motive power required to drive the machine it was expanded, and thereby reduced in temperature 140° or 150° below the initial temperature, registering in some portions of the voyage as low as 100° below zero.

This identical machine has since been used with much larger meat chambers than were connected to it during the first voyage, and has brought regularly every month from





REFRIGERATING APPARATUS, S. S. STRATHLEVEN AND DUNEDIN.



REFRIGERATING MACHINE FOR COOLING SHIPS' PROVISIONS.

America, more than 150 tons of meat each voyage. The first machine employed in the American trade was also of a similar type and size, and crossed the Atlantic in March, 1879, also under the personal superintendence of Mr. Coleman. Indeed fifteen machines of exactly the same size as the original Strathleven machine have been constructed, but the total number of machines made under the superintendence of the Bell-Coleman Company is forty-three, their aggregate cooling power being equal to freezing 200,000 tons of flesh annually, and we understand they have run 200 voyages consecutively without any serious mishap. The Bell-Coleman Company attributes much of its success and immunity from mishaps to the drying pipes, which are a peculiarity of their system, and which prevent accumulations of snow in cylinder ports and passages, which even if no water is injected into compressors is always formed in large quantities by the liquefaction and freezing of the aqueous vapor existing in ordinary atmospheric air.

The largest meat cargo machines afloat at the present time are those on board the Orient Liner Cuzco and the ship Dunedin. Each of these machines has a pair of air compressors 21 in. diameter and 2 ft. stroke, and both were fitted up by the Bell-Coleman Mechanical Refrigerating Company; as also a very powerful land freezing machine supplied to the Government of New South Wales for the Sydney public abattoirs, this machine having two air compressors of 23 in. diameter and 3 ft. stroke.

The arrangements made on board the Dunedin by the Bell-Coleman Company, which also supplied the boilers, is shown by the profile plan of the ship above, the machinery occupying less than 10 per cent. of the space to be cooled, which is estimated to carry 300 tons dead weight of meat.

We also illustrate a new type of machine of small dimensions for the cooling of ships' provisions, two of which have been recently put, and are now working on the Peninsular and Oriental steamships Rome and Carthage, which are the largest vessels of the fleet; one of these machines is about to be fitted on board the Kaiser-i-Hind in the place of the experimental machine which the Bell-Coleman Company first tried in Indian waters. These machines have air compressors of 14 in. diameter and 12 in. stroke, and steam cylinders of 13 in. diameter and 12 in. stroke. They are connected with meat storage chambers of about 900 cubic feet capacity, water coolers, vegetable rooms, etc., as shown on the plan.

These machines were carefully tried in the shops before being put on board in presence of the inspectors of the P. and O Company, and with cooling water of 90° gave temperatures of 40° below zero when the air pressure was 55 lb.; and 53° below zero when the air was 65 lb. pressure, an adjustable cut-off attached to the expansion cylinder slide enabling the pressure to be regulated at will. These machines are constructed with unusually large bearing surface, and run equally well at any speed between 80 and 200 revolutions, and it is claimed by the makers that their performance has not been exceeded by machines of same size, larger machines giving always lower temperatures—reaching to 80° or 100° below zero.

The lettering applying to the Strathleven plan applies also to the Peninsular and Oriental arrangements; and the Peninsular and Oriental machinery has been designed sufficiently large to admit of working a portion of a day, instead of keeping going the full twenty-four hours

A Bell-Coleman machine for cooling the ship Inverness has been fitted and set to work on board the Cunard steamer Servia.—*The Engineer.*

THE NEW DRY DOCKS AT THE ERIE BASIN.

ON Red Hook Point, Brooklyn, N. Y., are two dry docks which are being rebuilt and enlarged, and which, when completed, will be the largest of their kind in this country. These docks were originally constructed by Boston capitalists and remained in their control until quite recently, when they were purchased by New York parties who are now carrying on the work.

Some twenty years ago the waters of New York Bay covered nearly all that portion of Red Hook Point in the vicinity of the present Erie Basin. The land was submerged to a depth of about six feet, and the work of reclaiming was initiated by private individuals. The flats were filled in, the basin was protected by a massive sea wall, piers were built around the inner edge, store houses sprang into existence, and as the depth of water had been made sufficient to float the largest vessels that could pass the Sandy Hook bar, a large foreign trade was soon drawn to the neighborhood. Mr. James E. Simpson selected this locality as a favorable site for a dry-dock, and was commissioned to construct two docks in accordance with his patents. Nearly two years were required to build them, the cost being $1,500,000. When completed they were pronounced to be the best of their kind in this country, and so pleased were the directors of the company (then known as the Erie Basin Dock Company) that they presented Mr. Simpson with a check for $5,000. Dock No. 1 was opened for business in 1866, and No. 2 in the following year. Their dimensions were as follows:

	No. 1. Feet.	No. 2. Feet.
Length on coping	487	500
Length on floor	450	467
Width on coping	124	100
Width on floor	56	45
Width of entrance	90	100
Draught of water	17	22·7

A little over three years ago the company decided to make a number of alterations in No. 2, the larger dock. Shortly after these had been finished, at an expense of $500,000, an accident occurred which in a moment swept away the work of years and nearly demolished the entire structure. A small stream of water was one morning discovered running through the earth at the bottom of the coffer-dam built across the mouth of the dock. The stream rapidly increased in volume until the coffer-dam was undermined, when it gave way with a crash, letting in a roaring torrent that tore up everything in its course, tossed heavy timbers about like straws, and sent a shower of spray and splinters whirling far inland. Dock No. 1 was somewhat injured, and was allowed to fill with water. No attempt was made to rebuild or repair, and the docks remained a burden on the company's hands until last February, when the property was bought by a number of New York capitalists, who organized under the name of the Anglo-American Dry Dock and Warehouse Company. This company secured the services of Mr. Simpson, and eight months ago began to rebuild the docks on an enlarged scale, so that No. 2, when completed, will contain any vessel in the world and her cargo, excepting the Great Eastern.

The method of building one of these docks is well illustrated in this case, as the work, with the exception of the excavating, is shown in all its details. As the basin was filled with water, a coffer-dam was built across its mouth, in order to shut off communication with tide-water. After the water had been pumped out, a row of piles was driven along the center of the basin from one end to the other. These constitute the foundation upon which the bolted timbers forming what is known as the keelson rest, and upon which in turn the vessel to be repaired is balanced upon her own keel. Brace piles are driven on the sides of the basin from top to bottom for the support of the wooden walls of the dock. Around the entire basin sheet piling is driven—unless the nature of material encountered render this unnecessary—to a sufficient depth in the earth, thus forming a perfect cut-off and preventing the passage of any water. The space between this cut-off and the brace piles is filled with material taken from the basin when deepening, which is rammed hard, thus forming a perfect union with the ground floor, which has also been puddled, the whole being water proof. The dock increases in width from the bottom to the top at an angle of 45°. The brace piles support the altars or steps, which run from the top to the bottom of the two sides and one end of the basin, thereby affording a convenient means of descent to, and ascent from, the dock floor. Upon each side of the entrance to the dock are two massive abutments, protected from the water by strong sheet piling. As the safety of the entire structure depends upon these, they are built in the strongest possible manner and thoroughly protected. The gate fits into grooves running down the inclined sides of the abutments and across the floor of the dock. The gate is of iron and ballasted with stone and water. Running through the sides of the gate, below low-water mark, is a number of culverts, or openings, which can be closed by means of valves, when it becomes necessary to prevent inward flow of water in order to empty the basin. In docking a vessel the dock is first filled with water, which enters through openings. This operation requires about three-quarters of an hour. When the water within has reached the same level as that without, the openings in the gate are closed and the water which forms part of its ballast is pumped out. In a short time the gate floats out of the grooves and is towed to one side while the vessel is being floated in, when it is towed back, water pumped into it, and it gradually sinks to its resting place. The grooves are rubber lined, so that a water tight joint is formed by the pressure of the external water. The water in the dock is then pumped out, the vessel placed on an even keel, and held in position by the bilge chocks. For pumping out water there are two engines of 250 horse-power each, and two cataract pumps with a suction diameter of 30 inches.

The dimensions of the docks, as reconstructed, are as follows:

	No. 1. Feet.	No. 2. Feet.
Length on coping	500	600
Length on floor	450	500
Width on coping	124	120
Width on floor	56	50
Width of entrance	85	85
Draught of water	20	25

The Brooklyn docks have been leased for a term of fifteen years by the firm of William Cramp & Sons, ship and engine builders, of Philadelphia.—*Engineering News.*

MACHINE FOR BEATING FABRICS.

FOR certain usages there are employed machines that are provided with rods which strike and beat the fabric. This operation has been performed for a long time on cotton goods before singeing, although it has rarely been mentioned or described. Even the technical manual of Karmarsch-Harting says not a word about any machine for beating fabrics, and so it is with many other works, although for the last ten years this operation has played an important *rôle* in the finishing of velvets. Alcan says that toward 1856, Montagnac took out a patent for manufacturing worsted velvet, and that his method differed chiefly from those formerly employed in that he added a beating machine. This author describes an apparatus of this kind, carefully constructed by Martin of Tarare. In Germany, machines of this kind have been constructed by Thomas, Esser, Behnisch, and others. We give herewith as an example, in the accompanying cuts, (Figs. 1 and 2), a design of a machine made by Tillmann Essor at Borcette.

The driving shaft, *b*, carries a fast pulley, *b'*, and a loose pulley, *b*, and gives motion to the cam-shafts, *e*, and the two sides of the machine, through the medium of the bevel wheels, *c* and *d*. Upon the fixed axles, *o o*, are mounted

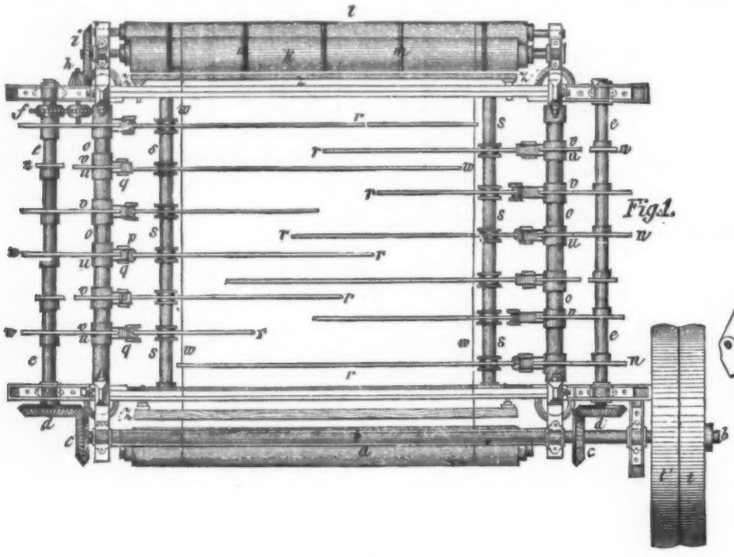


Fig. 1.

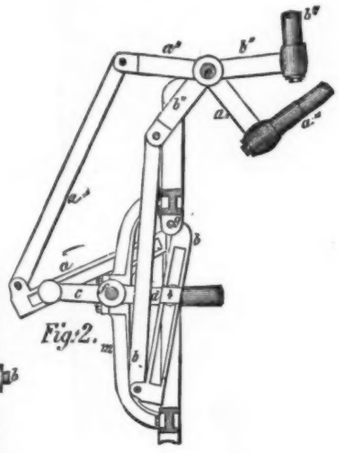


Fig. 2.

MACHINE FOR BEATING FABRICS.

cylindrical sleeves, *u*, which revolve thereon, and are provided with two arms, *p* and *v*, that are so arranged as to form a certain angle with each other. The arms, *v*, are bent and act as cams against which strike the cams, *n*, of the shaft, *e*. To the arms, *p*, are attached, on the one hand, the rods, *r*, which are to do the beating, and, on the other, the springs, *q*, which hold the arms, *p*, as if within a fork, and whose free extremities are attached underneath. When the shafts, *e*, revolve, the cams, *n*, come in contact with the cams, *v*, and cause the latter to descend; and, at the same time, the arms, *p*, rise with the rods, *r*, and the springs, *q*, give. At the moment the cams, *n*, leave the cams, *v*, the springs act, and suddenly bring down the arms, *p*, with the rods, *r*, which then strike the fabric. In order that the machine may perform continuous and steady work, the position of the cams is so arranged that the rods shall not all act simultaneously, but one after the other. The fabric is presented by the cylinder, *a*, which is covered with cards, passes under the beaters, and is taken up by the cylinder, *k*, which is likewise covered with cards. Slightly beneath the cylinder, *k*, there is located a smooth cylinder, *l*, and around these two, run in channels the endless belts, *m*, which serve for removing the fabric from the cards of the cylinder, *k*. The fabric is kept even and held at a uniform distance beneath the beaters by means of the bands, *z*. The travel of the beaters is limited by the cylinders, *w*, carried by the shafts, *s*.

All such systems were borrowed by Germany from France. At first the frames were made of wood, but they soon began to be made of iron. H. Thomas, of Berlin, builds machines with 16 to 20 beaters at from $300 to $450; Ruffieux, of Aix-la-Chapelle, employs only 10 beaters; Neubarth Longtain, of Verviers, furnishes such apparatus with a variable number of beaters, and gives the driving shaft a velocity of one hundred and twenty revolutions; Ed. Esser, of Gorlitz, constructs a machine with 12 beaters, etc. All these apparatus are preferable to the type represented herewith; but the machine made by Ch. Behnisch, of Luckenwalde, departs from the French form.

This manufacturer arranges the motion of the beaters in another way, and argues that, since in all known machines of this kind, the beaters are raised by cam-shafts and depressed by springs, the latter soon become weak and no longer act properly. Moreover, when the motor does not act regularly the merchandise at once becomes defective. As the springs always bring down the beaters in equal times,

varying with the tension of the springs, the beater can scarcely or not at all touch the fabric when the velocity of the cam-shaft is too great; while, if the velocity is too small, the beaters rub for a certain time on the moving fabric and effect a result through such friction which is just contrary to that which it is desired to obtain through the beating (that of raising the nap). If the tension of the springs is not well calculated, the action of the beaters is as defective as when the motor does not run steadily. Several of these arguments are irrefutable.

In the Behnisch machine the springs are done away with along with all the inconveniences that resulted from their use. But the inventor seeks to attain his object by employing crank mechanisms interposed between systems of levers, thus producing much friction and making the machine more costly and less durable than the French apparatus. The mechanism is shown in Fig. 2. Upon the shaft, *f*, are mounted the cranks, *c* and *d*, whose pins form slides which run in the slotted levers, *a* and *b*. The latter oscillate around an axis, *g*, and carry at their other extremities the connecting rods, *a'* and *b'*, which connect them with the bent levers, *a''* and *b''*, that revolve around the fixed axle, *e*, and carry upon their free arms the beaters, *a'''* and *b'''*. On each side of the machine there are placed various of these beaters, so arranged that the cranks of the axles, *f*, shall always assume positions that are opposite on the two sides, and thus produce a continuous alternation in the action of the two series of beaters.

The machines described serve also for beating fabrics in order to clean them before certain finishing operations. But for this purpose there have been constructed machines on a different plan, in which the beaters do not strike the fabric transversely but in the different directions of its length. A machine of this kind, designed for beating carpet, etc., with cam beaters and springs, has been invented by Solomon & Jasmin. A large number of American machines tends toward the same end. In MacArthur's machine are united apparatus for vaporizing, brushing and beating.

According to Alcan, the effect of beating damp fulled fabrics is to separate the free fibers, thread ends, etc., from the felt and bring them to the surface, in order that they may be more readily removed in teaseling and shearing. Besides, beating raises up the fibers from the teaseled or already sheared surface, and the extremities of the surface threads split and then take part in the formation of the velvet. It results from this that beating is an indispensable operation for all long napped fabrics, such as velvets and the like. The attempt had already been made to make velvets by hand beating, but it is only in recent times that, owing to the use of machines, this manufacture has reached a high state of perfection and uniformity. Beating, then, is specially applicable to woolen fabrics.

Mr. Behnisch, after describing the machines of former times and those of the present day, remarks that the finishing of goods for winter overcoats requires not only great care in the operations of teaseling, but also the application of a strong and uniform beating. In order that a proper result may be obtained, it is especially necessary to see that the moisture is evenly distributed throughout the fabric during teaseling, for this has the effect of simultaneously opening the under side. The fabrics should be very moist, but not wet, for beating. If the operation is performed on a too wet fabric, the latter generally retains the transverse impression of the beaters; if the cloth is too dry, the nap is only imperfectly raised, and readily falls down, thus detracting from the freshness and brilliancy of the fabric.

All fabrics which, after beating and drying, are submitted to treatment in the teaseling machine, can be folded behind the beating apparatus and support a slight pressure on being carried to the drying room; but goods which, after drying, are to be sheared for velvets only, cannot be submitted to the least pressure as long as they are still the least damp after beating, without depressing the nap so that it cannot be again raised properly. Spots due to such pressure, when they are observed in the yet damp goods, may be partially remedied by beating the fabric on the wrong side; but, as just stated, they can never be entirely removed. For these velvety fabrics there should be located behind the beating machine a drawing frame on which they should be placed until several workmen can remove them and carry them unfolded to the racking. If it is impossible to shear them at once after drying, it is well to hang them up by the selvages, and not lay them out horizontally and folded. For shearing, the longitudinal shearing machine, with as few brushes as possible, is preferably employed.

APPARATUS FOR DRYING PASTEBOARD.

IN the apparatus invented by Mr. Keil, of Berlin, shown in the accompanying Figs. 1, 2, 3, and 4, the pasteboard to be dried is put into frames which fold together and which are connected by means of the uprights, A (Fig. 4), and bands, *s*, in such a way as to form a wide, endless chain. The uprights are provided with three guiding rollers, B, the lower of which, supporting the whole, runs in a ⊔ shaped guide or rail, *c*, fixed on a base of corrugated iron. The two other rollers are guided laterally by the flat rails, D and E, (Fig. 3). These guides are curved, as shown in the plan (Fig. 1), so that the chain, which is composed of 104 "links," so to speak, follows a spiral line and rolls at the other end around a drum with cams, M, which is put in motion by the pulleys and belts, O, P, Q, thus causing the chain to move forward.

Beneath the iron plate flooring of the drying chamber, *f* (in which is placed the rolling chain), is found the fire-place, *b*, and the hot-air pipes, *a*, which lead the heated gases into an iron chimney, *d*. The apertures, *c* (Fig. 3), allow the air from the factory to enter the space occupied by the pipes, *a*, and to become heated, according to Mr. Keil, to seventy degrees; after which, it enters the drier, *f*, through the apertures, *e*, in the corrugated iron base. After becoming cooled and saturated with moisture, the air passes through vertical flues, *o*, into the space, *h* (situated above the corrugated iron covering of the drier), and escapes through an exhausted chimney, *i*, about sixty feet in height.

According to data furnished by the inventor the operation of drying takes about an hour for thin pasteboard.

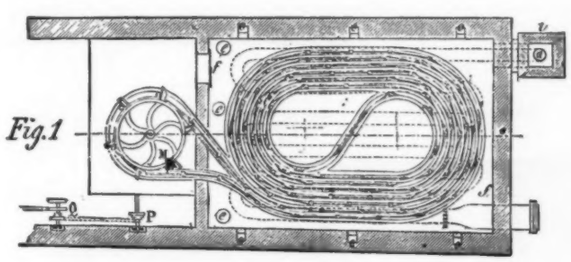


Fig. 1

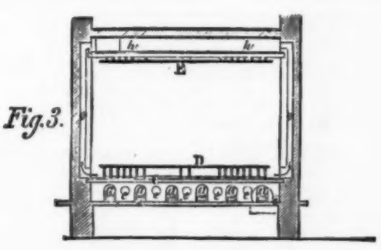


Fig. 3.

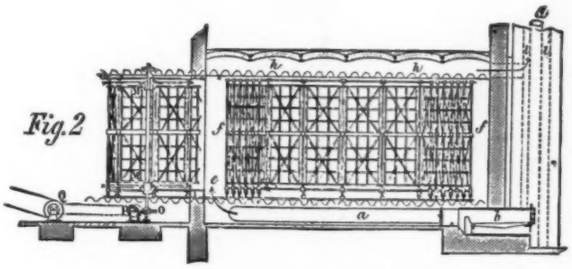


Fig. 2

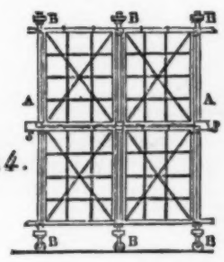


Fig. 4.

APPARATUS FOR DRYING PASTEBOARD

SECONDARY BATTERIES.

ON GROVE'S, PLANTE'S, AND FAURE'S SECONDARY BATTERIES.

By PROF. W. GRYLLS ADAMS, F.R.S.

AT a recent meeting of the King's College Scientific Society, Prof. Adams read a paper on this interesting subject. The first part of the paper was principally historical, showing that the effects on which the action of secondary batteries depends have been known since the beginning of the century. Volta discovered his battery in 1800, and in 1801 Gautherot observed the action usually ascribed to polarization. In 1803, Ritter, of Jena, also observed the phenomenon, and devised a battery for making use of the currents. Volta and Marianini, and afterwards Becquerel, investigated the action. Grotthus, in 1805, and Sir Humphry Davy, in 1806, attempted to explain the phenomena, as did De la Rive in 1825. In 1833 Faraday attacked the subject, and set the whole theory of electrical decomposition on a firm basis in his four series of papers communicated to the Royal Society between June, 1833, and March, 1834. Prof. Adams described the work of Faraday and the laws of electrolysis deduced from this work. "The chemical power of a current of electricity is in direct proportion to the absolute quantity of electricity which passes." Faraday powerfully reasons as to the identity of voltaic and machine electricities. He says:

"One grain of water, acidulated to facilitate conduction, will require an electric current to be continued for three minutes and three quarters of time to effect its decomposition, which current must be powerful enough to retain a platina wire one one-hundred-and-fourth of an inch in thickness, red-hot, in the air during the whole time; and if interrupted anywhere by charcoal points, will produce a very brilliant and constant star of light. If attention be paid to the instantaneous discharge of electricity of tension, as illustrated in the beautiful experiments of Mr. Wheatstone, and to what I have said elsewhere on the relation of common and voltaic electricity, it will not be too much to say that this necessary quantity of electricity is equal to a very powerful flash of lightning. Yet we have it under perfect command; can evolve, direct, and employ it at pleasure; and when it has performed its full work of electrolyzation, it has only separated the elements of a single grain of water."

Subsequently Professor Adams said: "He (Faraday) may almost be said to have discovered a secondary battery similar to that of M. Plante or M. Faure. When using acetate of lead for his solution he finds that the results at both electrodes are peroxide of lead appearing at the positive and lead itself at the negative pole."

In 1843 Grove made an important addition to the problem when he invented his gas battery, which Professor Adams discussed at some length, afterwards referring to the units adopted for the various measurements required in relation to this subject. The latter part of the paper was devoted to the consideration of the question of storage of electrical energy.

We may store up electrical energy of very high potential in a Leyden jar or condenser, and make use of it at intervals instead of taking it continuously from an electrical machine. We cannot raise the potential of the charge in the Leyden jar any higher than the potential of the machine from which it is charged. We may as well expect heat to flow from a cold body to a hot one and make it hotter, or think we can get water of its own accord to flow up a hill into a reservoir at the top. In connection with this question of storage of energy it may help us to trace the analogy between difference of potential with regard to electricity and difference of lead with regard to the force of gravity. The difference of potential giving rise to electromotive force between two points which are united by a conductor causes a current of electricity from a point of higher to a point of lower potential, just as a difference of level giving rise to pressure between two points in a water channel causes a flow of water from the higher to the lower level. The electromotive force corresponds to pressure, and the resistance of the circuit corresponds to the hinderances to the flow; the current corresponds to the quantity of water flowing per unit of time. Thus, of two paths from one level to another, the current will be most rapid along the steepest channel, and in the same way with the same electromotive force, the greatest current will be along the line of least resistance.

The electricity supplied by the electrical machine will be like a very small stream supplied by a pump at a very great height, and discharging itself by a small pipe at a very much lower level, so that it is capable of exerting very great pressure, but when allowed to run it can do very little work because the quantity is small. The Leyden jar is like the reservoir into which the water is pumped at a high level, and when the size of the reservoir is increased we know how difficult it is to prevent leakage from the very great pressure exerted by the water, and how dangerous the bursting and discharge from such a reservoir may be to those on the lower level who may happen to be on the path of the discharge.

On the other hand, the ordinary Grove battery which gives us electricity in abundant quantity, but of small difference of potential, is like a means of obtaining, when required, an ample supply of water as from a large reservoir not far above the level when it is wanted to be used, and so giving an abundant supply at low pressure. Had this mode of supplying electricity continued to be the principal one, we should, probably, not have so much need, and should not hear so much of secondary batteries; for, instead of burning up the zinc in the Grove battery to charge up the secondary battery like a large reservoir to-day, in order that the stored-up electricity may be used to-morrow, it would, probably, be better not to charge the Grove battery until to-morrow, and then use it directly to do the work required.

The development of Faraday's discovery that the motion of a coil of wire in front of the poles of a magnet or in a magnetic field gives rise to an electric current in the wire has shown us that the burning of zinc or other materials in batteries such as Grove's or Daniell's is a very expensive way of producing an electric current, and that it is far more economical to obtain electric currents by employing the best mechanical means we have to produce rotation of the coil of wire of the magnetic field. The different magneto and dynamo-electric machines (and they abound) are but the results of attempts to find the best form of coil, the best kind and best form of magnets, the best proportion of resistances, and the most suitable arrangements for the special work in each case which is required to be done. The dynamo-electric machine, driven by a steam engine or by a gas engine, is very satisfactory as a mode of producing electricity, and both the electromotive force and the current increase with the rate of rotation of the coil. This mode of producing electricity is like raising water to any level that may be required in each particular case; but the electricity must be used at once, while the steam engine, or the gas engine, is in action. This may be very inconvenient, and hence the necessity for something like a reservoir to store up the electricity. The labors of Faraday have shown us the relation between the quantity of electricity and the weights of the chemical elements decomposed by it in an electrolyte, and that these chemical elements may unite again to reproduce the same quantity of electricity. The object, then, to attain by means of secondary batteries is to

find some substance which can be decomposed into two others which will remain apart, even when joined by a liquid conductor, until a complete electric circuit is made. Then these two substances should be at considerable difference of potential, so as to give a strong electric current in uniting again to form the substance from which they were decomposed.

In 1859, M. Plante, taking advantage of the great affinity of peroxide of lead for hydrogen, made use of this substance to increase the effects of secondary batteries, and so was led to make use of lead electrodes instead of platinum, which has been the metal hitherto employed. He found that better results could be obtained with one cell with lead electrodes, than with two cells with platinum electrodes. So from this battery, plates of lead with a finely divided layer of lead upon them are taken as electrodes. A current from two Grove cells is sent through the cell containing them, immersed in dilute sulphuric acid of strength about 1 to 10. The current is sent for a quarter of an hour in one direction, then the cell is fully discharged, the current from the primary battery is then sent through it for a quarter of an hour in the opposite direction, after which the cell is again discharged. In this way it is charged over and over again in opposite directions for longer and longer periods, care being taken each time that the secondary cell is fully discharged. Then the battery is again charged, but when it is capable of giving out the charges slowly enough for the purpose for which it is to be used, then the successive charges should no longer be given in opposite directions, but always in the same direction. We may say that after the battery is formed, it should always be charged in the same direction.

In charging by sending a primary current through the cell, peroxide of lead is formed at the positive pole, and the negative pole becomes somewhat crystallized. When detached, the peroxide of lead forms the positive pole of the secondary battery, and the battery will remain in action until the two plates return to the same state, the positive pole being reduced from the peroxide to the oxide of lead, and the negative pole being transformed from lead to the oxide of lead.

M. Plante has especially aimed, by means of his battery, to convert electricity obtained from an ordinary battery into electricity of high tension, to do in a smaller degree what is done by means of the Ruhmkorff induction coil. By means of two cells of Grove or Bunsen he can charge a great number of cells, a dozen or more, arranged for quantity, *i. e.*, with all their positive poles together and all their negative poles together, and when they are charged by arranging them in series, *i. e.*, with the positive pole of one joined to the negative pole of the next, he can get great electromotive force, and at the same time obtain electricity in great quantity.

By his battery of 800 cells, which he has set up in Paris, and by the aid of his rheostatic machine, which I have not time to describe, he can imitate lightning discharges and remarkable luminous effects, somewhat analogous to the brilliant effects of the aurora borealis.

The electromotive force of a single cell of Plante's battery is about 2½ volts, or 2½ times that of a Daniell's cell, *i. e.*, about 1½ times Grove's cell, hence, two cells of Grove will charge a Plante cell. The quantity of electricity that may be collected will depend on the amount of chemical action, *i. e.*, on the extent of the surface of the plates, and on the way in which that action has gone on. When the action has gone on rapidly the battery will not be so good as when the action is slow. The Plante battery, as usually formed, discharges itself too rapidly for many purposes for which electric accumulators are now required, and hence other secondary batteries or modifications of the Plante battery are now making their appearance. The cells may be charged by a dynamo-machine, and may also be used to drive a dynamo-machine like an electro-magnetic engine or motor, driving it in the same direction as it was driven when used as a generator to charge the cells.

The Plante cell will also heat a platinum wire of considerable diameter, for although the electromotive force is only 2½ volts, yet the quantity is sufficient to make a platinum wire 3-10ths mm. in diameter and 4 cm. in length to glow for half an hour.

The secondary battery may be made use of in telegraphy to do away with the residual magnetism in an electro-magnet, so as to enable it to work more quickly after a current has been sent through it. The secondary cell should be attached with its positive pole to the line, and its negative pole to the key, the other end of the line or the earth being also attached to the key, so as to form a complete circuit when the key is up; the sending battery, consisting of two or more cells of Grove, or at least three Daniell's cells, should have its negative pole attached to the negative pole of the secondary cell and its positive pole to the key; so as to form a complete circuit with the line and secondary cell when the key is down. When contact is made with the sending battery by putting down the signaling key, the circuit is sent through the secondary cell into the line, thus giving a slight additional charge to the secondary cell, and bringing the electro-magnet into action; on breaking contact by releasing the key, the secondary cell, being still connected to the line, sends a reverse current into the line, and weakens or may even be strong enough to reverse the magnetism of the electro-magnet. If we work a Morse instrument first, with the sending battery alone, and afterward with the secondary cell in the circuit, we find that there is a very great increase in the rate of signaling when the secondary cell is used. The secondary current increases as the battery current increases, and, being in the reverse direction, instantly weakens the magnetism of the electro-magnet, so that signals may be sent as fast as the operator can make and break contact. Plante's secondary battery has been employed to work an electric brake on railway trains. With two Grove cells or three Daniell's cells and a Plante cell arranged as above described, the Plante cell is continually being charged, or is kept from getting weaker, except when the key is depressed which completes the electric circuit by which the brake is set in action. The quantity of electricity stored up in six Plante's cells suffices, with such an arrangement to prevent the cells from becoming exhausted, to work the brakes on a dozen railway carriages, and to last for a fortnight. To renew the charge in the Plante cell a battery of six Daniell's cells may conveniently be employed. It is important that the charging should be carried on with great regularity, so that the layer of peroxide of lead may be regularly laid on, otherwise it will not adhere well to the lead electrodes.

Several forms of secondary batteries have appeared quite recently, now that the demand has arisen for a reservoir in which to store up the electricity produced by the dynamo-electric machine, and the secondary action or polarization of batteries is no longer regarded as something to be avoided as much as possible, but is eagerly sought after. Professors Houston and E. Thomson, of Philadelphia, have tried electrodes of copper in sulphate of zinc. When a current is sent through the cell, zinc is deposited on the negative pole, and sulphate of copper formed around the positive pole, the plates being laid horizontally, so that the sulphate of copper so formed, and the sulphate of zinc shall be prevented by their relative weights from mixing too readily.

This we may call a gravity secondary battery, and its electromotive force will be nearly the same as that of one Daniell's cell or 1 volt. M. d'Arsonval modifies this battery by using one electrode of lead and another of zinc in a solution of sulphate of zinc. The lead forming the positive electrode becomes coated, as in the Plante's cell, with peroxide of lead.

Several modifications of Plante's cell have been suggested, which have for their object the reduction of the weight of lead employed; such are the batteries of M. de Pezzer and of M. de Meritens, who fold their lamine of lead in layers like the leaves of a book, so as to get as much surface as possible for a given weight of lead. M. de Pezzer also finds that the relative size of the positive and negative plates modifies the results obtained, a greater quantity of electricity is stored up when the negative electrode is double the size of the positive electrode than when the two electrodes are of the same size.

Other modifications, in which the negative pole is either palladium in dilute sulphuric acid or thin sheet iron in a solution of sulphate of ammonia, have been suggested and employed by M. Rousse, these substances being chosen on account of their great power of absorption of hydrogen. These can hardly be called secondary batteries, since two metals are employed as electrodes.

The method of charging secondary batteries may sometimes be conveniently made use of to renew ordinary batteries which have become used up. Thus, a Leclanche cell which has been in use for a long time, and become weak, may be recharged again by connecting up the positive pole of a stronger battery with the positive pole of the Leclanche battery, and allowing the current to pass through it for a considerable time. The secondary battery to which most attention has been drawn during the last few months is the Faure battery, in which M. Faure does not form the cells by electrolysis, but coats the lead plates with a film of red lead or minium, inclosing or protecting the red lead coating with a layer of felt. His cells are of large size, and each is therefore capable of storing up a considerable quantity of electrical energy. The chemical action is similar to the action in a Plante cell, but the resistance is higher, and when in use the battery takes longer to discharge itself, so that for electric lighting and for many purposes for which a store of electricity is required it seems to be better adapted than the Plante cell. It has been said, and the statement has been confirmed by Sir William Thomson, that a "Faure accumulator, weighing 75 kilogrammes (165 lb.), can store, and give out again, energy to the extent of an hour's work of one horse-power," or two million foot-pounds. At first these cells were made cylindrical, and the Faure Accumulator Company have kindly lent me a box of four such cells in action, similar to the celebrated box of electrical energy or condensed lightning, so graphically described in the *Times* of May 16 last, which was carried from Paris to Glasgow for examination and measurement by Sir William Thomson. They have also lent me one of their latest forms, in which the plates are flat, and placed vertically in the box. It has been ascertained by Sir William Thomson that Faure's accumulators, amounting in weight to three-quarters of a ton, will continue to work for six hours from one charge at the uniform rate of one horse-power, and that probably 90 per cent. of the energy spent in charging will be transformed into useful work. Very few comparative trials have been made of the Plante and the Faure batteries, but from those which have been made by M. Achard, it appears, that, as might be expected, they are equal in electromotive force, that the Plante cell is of smaller resistance than the Faure cell, and, consequently, will heat a longer piece of platinum wire, and do its work three times as rapidly. The Plante cell kept a platinum wire 3-10ths mm. in diameter and 5 or 6 cm. long red hot for half an hour, and the Faure cell kept the same wire red hot for an hour and a half. We may readily see by a few experiments that the Faure's battery has collected a great quantity of electrical energy, for one box of it will cause a platinum wire of considerable length, and 1 mm. in diameter, to glow, and one cell is sufficient to drive a small dynamo-electric machine as a motor, or to drive a small electric engine, and the three or four cells are sufficient to cause a small Swan's incandescent lamp of small resistance to give out a very pleasant light of about two candles. There are many applications which may be made of secondary batteries. Six Plante cells have been found sufficient to drive a tricycle with 160 kilogrammes, or about 300 lb., upon it, at a rate of ten miles an hour, or to drive a boat containing three persons.

(1.) These secondary batteries may be used to carry a supply of electricity, where it is wanted.

(2.) They may acumulate supplies from a dynamo machine and store energy up for electric lighting or for motive power.

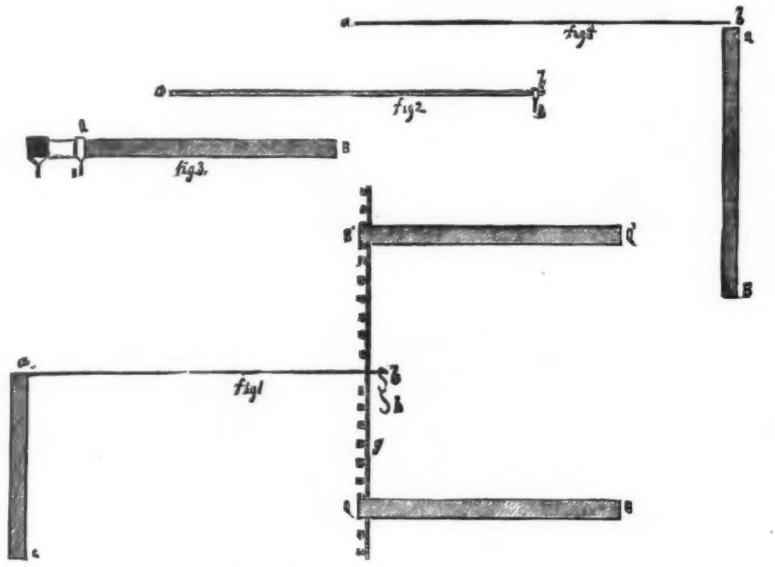
(3.) They may serve as regulators for the electric current, when as in electric lighting it is liable to fluctuations, either from the irregularity of the driving engine, or from the change of resistance in the electric arc or in the electric circuit. When so used, they would supply and keep up the light, even though the engine were suddenly to stop, or any accident to happen other than the cutting of the connecting wires.

The Faure's accumulator has been employed to light a railway train from London to Brighton by means of incandescent lamps, to work an electric motor so as to drive a circular saw or other mechanical tools, and it has been employed with very satisfactory results in driving a tramway in the streets of Paris, and in the Siemens electric railway between the Electrical Exhibition and the Place de la Concorde. The results already attained seem to show that there is no other secondary battery which can compare with this for storing up and keeping for a long time a supply of electric energy, and for using it slowly when in action.

MAGNETIC DYNAMOMETER.

By DR. ANTONIO COSTA SAVA, Professor of Physics in the University of Messina.

THE principal part of this instrument consists of two magnets, *a b*, Q B, and a scale, *d g* (Fig. 1), arranged upon a rectangular base of wood. The two magnets are placed one above another in such a manner that the axes of symmetry are horizontal and in the same vertical plane. Each of these two magnets carries a very slender index, *i* (Fig. 2), l



MAGNETIC DYNAMOMETER.

(Fig. 3), placed at right angles with the axis of symmetry and in the medium horizontal plane of the thickness.

The first magnet, *a b* (Fig. 1), is formed of a long, narrow and thin spring of steel, which is fixed horizontally at one end, *a*, to a perpendicular support, *a c*, and left free at the other extremity, *b*; the latter carries the index, *i*, which by bending *a b* slides along the scale, *d g*; this scale is finely divided into equal graduations, and can be raised or lowered. In order to secure the scale in its exact position before experimenting, the second magnet, Q B, is removed from its support and the scale fixed by means of a set-screw, so that its zero corresponds precisely to the index, *i*, of the spring *a b*. The plane upon which the magnetic dynamometer is placed during experimentation ought to be very firm, and it should not be affected by the oscillations of the floor.

The second magnet, Q B, is placed upon a movable toothed support, by means of which it can be approximated to the other magnet, *a b*, or removed from it. Upon the button of the rack-work is a set-screw to fix the support of the magnet, Q B, at the desired height.

In such an instrument the magnetic attraction or repulsion is counterbalanced by the elasticity of flexion. The following experiments will exemplify the method of working the appparatus.

FIRST EXPERIMENT.

The magnet, Q B, is removed from its support, and removed so far from the instrument that it cannot act upon the spring-magnet, *a b*; then it can be demonstrated that the inflection of *a b* is proportional to the force which produces it. At *b* there is suspended a very slender copper wire of the form of S for the purpose of lowering the index, *i*, a short distance, *l*, from the scale, *d g*; to the weight there is appended a second one, A, of equal weight, so that the index can be lowered to 2 *l*, and by means of other weights this lowering can be extended to any degree sufficient for the use for which the instrument is intended. If the chain of weights, *b* A, be removed, the index will return to the zero of the scale, *d g*. This experiment shows that within certain limits the inflections of the spring, *a b*, are proportional to the force which produces them.

SECOND EXPERIMENT.

The magnet, Q B, is placed upon its support in a direction parallel to *a b*, as is indicated in Fig. 1, and in such a manner that its magnetic pole, Q, corresponds to the contrary magnetic pole, *b*, of the spring magnet, *a b*; moreover it is placed near the scale, *d g*, before which extends the index, I, fixed to a ring. This arrangement enables the index, I, to be placed at a convenient distance from the scale upon which are marked the different heights at which the magnet, Q B, is placed on raising or lowering it.

This being done and the magnet, Q B, being always kept in a parallel position, it is brought to a certain distance from the spring, *a b*, in such a manner as to cause a lowering of the index, *i*; and preserving this, the magnet, Q B, is moved slowly backward and forward to find the position which corresponds to the maximum depression of the index, *i*; in such movements the axis of the magnet, Q B, ought not to change its distance from the other magnet, *a b*, nor be removed laterally. When such a position of the magnet, Q B, is found, it is fixed with a set-screw, and then the magnetic dynamometer is ready for experiments, by means of which it is demonstrated that magnetic attraction varies inversely as the square of the distance.

THIRD EXPERIMENT.

The magnet, Q B, is removed from the magnet, *a b*, until its index, *i*, marks a slight depression, *l*, and then the corresponding distance, *d*, of the two poles, *a b* (measured from the distance of the two indices, *i*, I), is noted.

This being done, the magnet, Q B, is approached to *a b*, it being always kept in the same parallel position, so as to reduce to $\frac{1}{2}$ *d* the distance of the two poles, *a b*; it will then be seen that there is a depression of the index, *i*, quadruple that formerly obtained, or 4 *l*. Thus it is shown that the magnetic attraction between the two poles, Q and *b*, varies in the inverse ratio of the squares of their distances. On reducing then the distances of the two poles to $\frac{1}{3}$ *d*, the depression of the index will be 9 *l*, or ninefold the first, as it ought to be according to the law in question.

In making such experiments it is necessary to avoid a too close proximity of the magnets, and the first depression, *l*, must be very small.

If it is desired to make a large number of experiments in confirmation of the said law, the following method may be employed.

FOURTH EXPERIMENT.

Let *l*, l^1, be equal depressions of the index, *i*; and *d* d^1, the relative distances of the two poles, Q and *b*, then in accordance with the known law

$$(1) \qquad l, d^2 = l^1, d^{1 2}$$

$$\text{whence } (2) \qquad d^1 = d \sqrt{\frac{l}{l^1}}$$

Let us suppose that at the known distance, *d*, there is a known depression, $l = 0{\cdot}2$ of the scale by the index, *i*, then (2) we have

$$(3) \qquad d^1 = d \sqrt{\frac{0{\cdot}2}{l^1}}$$

If we wish to know the distances, d', d'', d''', etc., of the two poles, *a* and *b*, corresponding to the depressions, $l' = 0{\cdot}4$; $l'' = 0{\cdot}6$; $l''' = 0{\cdot}8$, etc., it is sufficient to substitute for l', in the equation 3 the numerical values of the distances d', d'', d''', and approximating successively the pole, Q, to the pole, *b*, there are obtained the depressions corresponding to the index, *i*, in conformity with the law above mentioned.

MAGNETIC REPULSION.

To prove the same law for magnetic repulsion, the magnet, Q B, is placed above *a b*, in the position B' Q' (Fig. 1), parallel to *a b*, so that the two homonymous poles, *b* and B, of the two magnets may correspond in the same perpendicular. To the latter is adapted the ring which carries the index, I, laying hold of the pole, Q, which, in this new position, will correspond to Q'.

By this arrangement of the two magnets, the index, *i*, of the magnet, *a b*, will be depressed by the magnetic repulsion between the two similar poles, B' and *b*. The experiments may be made in the same manner which was employed for demonstrating the law of magnetic attraction.

DISTRIBUTION OF MAGNETISM IN A MAGNET.

The instrument in question is useful for studying the distribution of magnetism in a magnet, Q B. For this purpose it is not placed in a parallel position, but in such a manner that the axes of symmetry of the two magnets, *a b*, Q B (Fig. 4), may be situated horizontally at different heights, and in two planes, vertical and perpendicular. This position of the magnet, Q B, is called the perpendicular position, to distinguish it better from the parallel position.

Let Q B be placed in the perpendicular position under *a b* (Fig. 4) so that the two contrary poles, *b*, *g*, may correspond in the same vertical, and at such a distance as to have a depression of the index, *i*, equal to 9 *l*. This being done, the needle, Q B, is moved very slowly, so that its different sections may correspond successively in the same vertical of the pole. *b*; the index, *i*, will be raised till it returns to zero, and if the movement of Q B is then continued, the index will be pushed in the opposite direction, passing above zero, and rising till the homonymous pole, B, of the magnet, Q B, will be placed below *b*.

A T-shaped support assists in maintaining the magnet, Q B, in the perpendicular position, so that the above mentioned experiment can be made convenient.

In this and other experiments, it is useful for the magnet, Q B, to be adapted to a scale for better determining the corresponding section, in the same vertical plane, which passes through *b*, when the index, *i*, marks a positive or a negative deviation or none.

MAGNETIC ACTIONS THROUGH BODIES.

It is easy to demonstrate with this instrument that magnetic action is propagated without becoming weakened through many bodies. It is sufficient to interpose the bodies, holding them in the hand, between the poles of the two magnets placed in the parallel position (Fig. 1) so as to have a certain depression of the index, *i*. The index will then be seen to remain motionless on interposing between the two poles copper, glass, wood, etc., and to suddenly change its position if a plate of iron is inserted.

ACTION OF SOLENOIDS UPON MAGNETS.

It will be understood that the dynamometer may give cope for new studies on the reciprocal action between a solenoid and a magnet. It will be sufficient to substitute for the magnet, Q B, a solenoid, both in the parallel and in the perpendicular position.

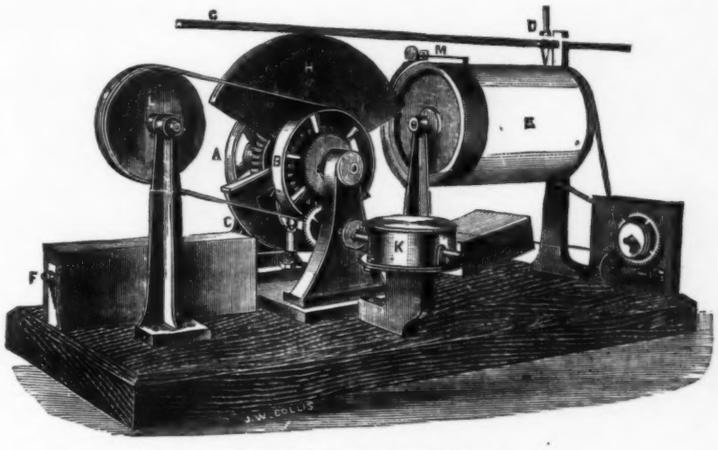
ELECTRIC DYNAMOMETER.

It would be possible to have an electric dynamometer founded on the same principles. It would be sufficient to suspend to the extremity, *b*, of the spring, *a b* (Fig. 1), a disk of gilt paper, or a ball of elder pith, and charge it with electricity. For the magnet, Q B, must be substituted a rod of varnished glass, which supports at one of its ends another pith ball, which is charged either with the same or with the opposite kind of electricity, according as it is intended to study electric repulsion or attraction. The electric dynamometer must be inclosed in a well-fitting glass case, within which some desiccating substance must be constantly kept. The method of experimenting will be analogous to what has been already described. But special care must be had to take account of the loss of electricity in the interval of time between successive experiments.

The inventor shows that the magnetic dynamometer is preferable to the old instruments for demonstrating that magnetic action varies inversely as the squares of the distances, as well as for other magnetic and electric researches. —*Telegraphic Journal.*

IMPROVED DYNAMOMETER.

IN the British section Mr. Paterson shows the transmission dynamometer of Professor Ayrton and Perry, which has been so recently illustrated in our columns that it is unnecessary to refer more to it. A transmission dynamometer is shown at the Paris Electrical Exhibition by Mr. F. J. Smith, of Taunton, England. The construction of this instrument is as follows: The two pulleys, A B, each carrying a bevel wheel, and running loose on the same fixed shaft, are in gear with a third bevel wheel, the axis of which is carried at right angles to the axis of the other two by the sector shaped casting, C. This casting, while carrying the intermediate wheel, is capable of angular displacement, this displacement being controlled by a spiral spring within the case, F, which spring is attached to the sector in such a manner that its pull always acts tangentially to it. An upper sector of wood, H, fixed to the under sector and counterpoiser, carries on its edge a light rod, G D, attached to the sector by two cross cords. At D a tracing point records on the drum, E, an ordinate, which is a measure of the extension of the spring. The drum is driven by a screw and tangent wheel at a given



SMITH'S DYNAMOMETER.

ratio to the speed of the pulleys, A or B. A counter, K, is used to record the number of revolutions. The force transmitted during the investigation is known by finding the area of the diagram. The wheel and handle, L, is connected to the pulley, B, by a bell, to show how the apparatus works. The tracer, D, indicates the tension of the belt. The time during which the investigation lasts is shown by a lever, M, which carries a tracer. The lever is actuated by an electro-magnet connected to a seconds pendulum, so that the record is given in seconds. The dynamometer shown at Paris is a model, suited only for simple laboratory work, but the constructor states that other instruments similar in design have been used to transmit from 5 to 10 h. p.

EFFECTS OF TELEGRAPH WIRES ON ANIMALS.

SOME interesting facts are brought out in a paper by M. C. Nielsen, of Christiana, on the impression produced upon animals by the resonance of the vibrations of telegraph wires. It is found that the black and green woodpeckers, for example, which hunt for insects in the bark and in the heart of decaying trees, often peck inside the circular hole made transversely through telegraph posts, generally near the top. The phenomenon is attributed to the resonance produced in the post by the vibration of the wire, which the bird mistakes as the result of the operations of worms and insects in the interior of the post. Every one knows the fondness of bears for honey. It has been noticed that in mountainous districts they seem to mistake the vibratory sound of the telegraph wires for the grateful humming bees, and, rushing to the post, look about for the hive. Not finding it on the post, they scatter the stones at its base which help to support it, and, disappointed in their search, give the post a parting pat with their paw, thus showing their determination at least to kill any bees that might be about it. Indisputable traces of bears about prostrate posts and scattered stones prove that this really happens.

With regard to wolves, again, M. Nielsen states that when a vote was asked at the time for the first great telegraph lines a member of the Storthing said that, although his district had no direct interest in the line proposed, he would give his vote in its favor, because he knew the lines would drive the wolves from the districts through which they passed. It is well known that to keep off the ravages of hungry wolves in winter the farmers in Norway set up poles connected together by a line or rope, under which the wolves would not dare to pass. "And it is a fact," M. Nielsen states, "that when, twenty or more years ago, telegraph lines were carried over the mountains and along the valleys, the wolves totally disappeared, and a specimen is now a rarity." Whether the two circumstances are causally connected, M. Nielsen does not venture to say.

ELECTRIC LIGHTING — REPORT OF THE FRANKLIN INSTITUTE COMMITTEE.

AT the October meeting of the Franklin Institute a committee, consisting of R. E. Rogers, M.D., Chairman; William P. Tatham, C. M. Cresson, M.D., David Brooks, E. Alex. Scott, Edwin T. Houston, and Isaac Norris, M.D., Secretary, was appointed to consider the "dangers incident to electric light, if any, and the means of overcoming them." Their report, which is now only awaiting final revision, says that "from a careful consideration of the evidence submitted, they believe that the use of electricity as an illuminant, as now generally employed, is *not* attended with any danger either to person or property that cannot be obviated by the adoption of the precautions hereinafter set forth."

The report briefly describes the two systems of electric lighting—by incandescence and by the voltaic arc—explains the manner in which mechanical energy is converted into electric current by the dynamo machines, and particularly describes the difference in properties between the current produced by a frictional machine, which will leap through the air, and those from a dynamo machine, which do not possess this power.

The report says: "The currents from dynamo-electric machines or the currents employed in systems of electric lighting are not therefore at all comparable to strokes of lighting, to which they have often been ignorantly likened. Lightning discharges frequently pass through miles of air, but even in the largest machines the carbons employed in arc lamps must first be brought into contact and afterward separated before the arc is established and the current passes between them. The current will not, in fact, leap through the air. The momentary contact of the two carbons develops sufficient heat to form a cloud of carbon vapor between them, and this cloud, being an electrical conductor, permits the current to pass."

The report then describes the possible sources of danger from electric lighting, and sums up with the following

RECOMMENDATIONS OF THE COMMITTEE:

1. That the conducting wires leading into and out of the building be suitably insulated throughout their entire extent both to and from the machine producing the current.

2. That an inspection be made at suitable intervals to determine whether or not the insulation has been preserved intact.

3. That conductors, formed of numerous short pieces of wire, be avoided as far as possible, and that, where their use is necessary, the joined ends be made as secure as possible by wrapping, so as to prevent short arcs being formed at imperfect junctions, should the joined ends be partially separated from each other.

4. That the wires be not grounded; that is, that no attempt be made to cause the current to pass back to the machine through the earth, but that a continuous line of wire be provided through which the current shall so return.

5. That the ready occurrence of cross contacts or short circuits be avoided as follows, viz.: That the conducting wires from different machines or from different parts of the same machine be kept as far apart as convenient, and never, except when necessary, be brought nearer together than the distance between the two binding posts on any electric lamp used in the circuit.

That, therefore, the wire leading from the machine into the room to be lighted should leave the room as far as convenient from the place it enters.

That the wires be securely fixed in position, and be not allowed to sag or bend in wide curves, except where it is necessary to permit the rising or lowering of the lamp.

That judgment be exercised in selecting the portions of the building in which to run the wires. To secure as far as possible, the absence of moisture, ceilings are to be preferred to walls or floors, the latter being highly objectionable unless the wires are placed under the flooring. As before stated, the location selected should be removed as far as possible from metallic conductors. Select the places least liable to be rendered partially conducting by moisture, from any source, in which to run wires.

6. That the conducting wires be of sufficient size to carry the most powerful current employed without dangerous heating.

7. In order to avoid the danger to life from the accidental discharge of the current through the body, the conducting wires should in all cases, if convenient, be placed out of reach, either by choice of location or the use of heavy and guarded insulation.

8. That where lamps of the arc type are used they be covered with a globe of glass, and the lower end of such

globes be furnished with a cup or pan for retaining any heated fragments.

The committee, which makes a unanimous report, believes that if these precautions be taken electric lighting can be made thoroughly safe and reliable, and that all dangers attending its use can be entirely obviated.—*Philadelphia Ledger.*

THE SWAN SYSTEM OF ELECTRIC LIGHTING.

WE have already more than once spoken of this system, the origin of which dates from a somewhat distant epoch, but which has come to furnish entirely practical results only within a short period, and that as a consequence of certain manipulations in the preparation of the carbon filaments, which it appears to us of interest to describe in this place.

We have seen that, at the epoch at which Mr. Edison made his lamp known, the carbonized paper horse-shoes had neither any tenacity nor solidity, and this caused Mr. Swan to think for a moment that the problem would prove difficult of solution. However, at this very time he had announced that he was on the road to new improvements which might possibly furnish good results; but it was only toward the end of last year that his efforts were crowned with success and that his lamps began to make themselves known. To-day they are being employed in various places; in England, notably at Combes Bank Castle, the residence of Mr. Spottiswoode; and, at the Exhibition, it is they that light the Congress Hall, the Post Office Pavilion, and one of the halls near that of the President. They are again found at the office of the English Commissariat, and at the Exhibition of the Company "La Force et la Lumiere," etc. They have furnished, as we have been enabled to see, a very beautiful light, but we have not been able to fix on the number of lamps that correspond to a one-horse steam power. From what has been told us, the number would seem to be 15; but Mr. Swan, with commendable reserve, does not care to advance anything before profound study of the subject.

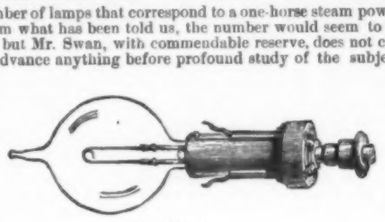


FIG. 1.

At all events, the current employed to light them is a powerful one, for their brilliancy is greater and their light is consequently whiter than that of other lamps of the same kind. However, Mr. Swan, in all his installations, has occupied himself only with the lamps themselves. He has combined no particular arrangement of electric generator nor of distribution. In some cases he employs Faure accumulators, in others Siemens machines, in others Brush machines, and it has even been ascertained that reversed alternating currents, like those of the magneto-electric machines of De Meritens, are particularly favorable, since with intense continuous currents the carbons are sometimes cut at the positive pole.

FIG. 2.—MR. SWAN'S ELECTRO-CHEMICAL SHOP AT NEWCASTLE.

We represent, in Fig. 1, a Swan lamp with its mounting, which allows of its very easy introduction into the bracket or chandelier which is to support it. It consists, as may be seen, of a glass sphere, into which are introduced two platinum carbon-holders having clasps and pressure ring precisely like porte-crayons that were once in use. The carbon filament, which is much larger at its extremities, that are grasped by the holder, is bent into a flat helix in such a way as to form a ring in the middle of the sphere and to accumulate at the center of the latter a greater quantity of light.

The preparation of these carbon filaments is a little different from that of the Edison carbons. They are made of threads or tresses of cotton about 10 centimeters in length, whose extremities are enlarged by a local winding of the material. These threads are dipped into sulphuric acid diluted with water, in the proportion of two parts of the former to one of the latter—the result of this operation being to parchment them. Under such conditions, and after a certain length of time, the threads become consistent and as hard as parchment. They are then introduced into powdered carbon contained in an earthen vessel which is afterwards hermetically closed and submitted to a red heat

FIG. 4.

for a certain length of time. After this they are placed in the lamps, and, when a vacuum has been created in the latter by means of the Sprengel pump, the precaution is taken to bring them electrically to incandescence so as to eliminate all the gases which might possibly exist in their pores. After this operation, which may take half an hour, the filament has become very hard, and at the same time denser and smaller. It is in this state that it becomes suitable for application. The resistance of these filaments varies between 30 and 100 ohms, and the light that they emit under ordinary conditions varies, according to Mr Swan, between 12 and 25 candles. In order to avoid calorific effects at the points where the carbon-holders are soldered in the glass, the holders are made to advance into the globes for some little distance, and are held by a glass cross-piece. The platinum wires to which they are soldered communicate with two flat springs (as seen in Fig. 1), on the two sides of the mounting, and, in order to introduce the lamp into its support, or to remove it, it is only necessary to press on these springs and afterwards release them; the electrical communications are established by this sole act.

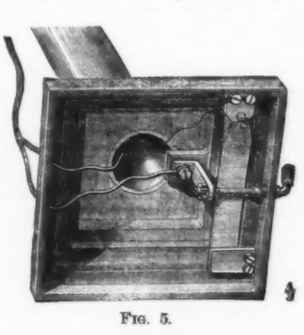


FIG. 5.

FIG. 3.—A STREET IN NEWCASTLE LIGHTED BY SWAN LAMPS.

In the accompanying Figs. 2 and 3 we show the appearance of a street in Newcastle lighted up by the Swan lamps, and the interior of the electro-chemical shop of this savant at Newcastle.

In Figs. 4, 5, 6, we show the way in which Mr. Swan has adapted his lamp to a portable support forming a chandelier, and the arrangements that he has combined for lighting the galleries of mines. Fig. 5 represents the bottom of the chandelier, and permits of the electric communications being seen.

At the present moment Mr. Swan is studying the mode of generation and distribution of electricity that he shall adopt

for his lamps; but he has not yet decided upon it, and meanwhile lights them with either accumulators or induction machines. Hall 21 he lights with the Siemens machine, and for the Congress Hall he employs that of Brush. According to Mr. De Meritens, the best arrangement of these lamps with the machines that he constructs would be to distribute them into five circuits, each furnishing 12 derivations, with 4 lamps connected with each other in each derivation With Brush machines, which furnish currents of relatively high tension, there may be supplied, it is said, per machine, one hundred and sixty lamps arranged in sixteen parallel circuits, upon each of which are placed ten lamps in tension. With

FIG. 6.

a large wire machine all the lamps must, on the contrary, be arranged in derivation.

In each case the nature of the machine must serve as a guide for the installation of the lamps, so as to obtain the maximum effect.—*Th. du Moncel, in La Lumière Electrique.*

LUNAR DISTURBANCE OF GRAVITY.*

IN November, 1878, Sir William Thomson suggested to Mr. G. H. Darwin that he should investigate, experimentally, the lunar disturbance of gravity and the question of the tidal yielding of the solid earth. This committee of the British Association was subsequently reappointed, and the authors' names were added to the list of its members. In May, 1879, the authors visited Sir William Thomson at Glasgow, and there saw an instrument which, although roughly put together, he believed to contain the principle by which success might perhaps be attained. The instrument was erected in the physical laboratory of the University of Glasgow. The following are the rough details:

A solid lead cylinder, weighing perhaps a pound or two, was suspended by a fine brass wire, about five feet in length, from the center of the lintel or cross-beam of the solid stone gallows which is erected there for the purpose of pendulum experiments. A spike projected a little way out of the bottom of the cylindrical weight; a single silk fiber, several inches in length, was cemented to this spike, and the other end of the fiber was cemented to the edge of an ordinary galvanometer mirror. A second silk fiber, of equal length, was cemented to the edge of the mirror, at a point near to the attachment of the former fiber. The other end of this second fiber was then attached to a support, which was connected with the base of the stone gallows. The support was so placed that it stood very near to the spike at the bottom of the pendulum, and the mirror thus hung by the bifilar suspension of two silks, which stood exceedingly near to one another in their upper parts.

It is obvious that a small displacement of the pendulum, in a direction perpendicular to the two silks, will cause the mirror to turn about a vertical axis.

A lamp and slit were arranged, as in a galvanometer, for exhibiting the movement, of the mirror by means of the beam of light reflected from the mirror. It was found to be in incessant movement, of so irregular a character that it was hardly possible to localize the mean position of the spot of light on the screen, within five or six inches. On returning to the instrument after several hours, the observer frequently found that the light had wandered to quite a different part of the room, and it was sometimes necessary to search through nearly a semicircle before finding it again. The cause of this extreme irregularity of the movement of the pendulum was obscure; and as Sir William Thomson was of opinion that the instrument was well worthy of careful study, the authors determined to undertake a series of experiments at the Cavendish Laboratory at Cambridge.

Accordingly throughout 1880 they proceeded to make experiments with an instrument which involved the principle above explained. Several modifications of some importance were introduced. The pendulum was hung in fluid, in order to quickly destroy the oscillations generated by local tremors, and, being suspended by two wires, it was only free to oscillate in one direction, namely, the meridian. There was also introduced an apparatus, which we have not space to explain, by which a known very small horizontal thrust might be applied to the pendulum. By means of this the actual displacements of the pendulum were determinable from the observed displacements of the spot of light on the screen.

The image on the screen was found to be in a state of continual agitation of an irregular character, so that it was not possible to take a reading with very great accuracy. But as the pendulum was hung in fluid, the agitation was not nearly so great as it had been in the instrument at Glasgow.

The observers also found that the pendulum was subject to a diurnal oscillation, and that it stood furthest north toward 6 P.M., and furthest south toward 6 A.M. Superposed on this motion was a gradual change of the mean diurnal position, for during two months the pendulum moved northward.

The instrument was found to exhibit the flexure of the stone piers of the gallows, even when the force employed was only a slight pressure with one finger. Water poured on the ground round the basement of the stone gallows tilted the whole structure over, and very small changes of temperature in the stone piers were found to give distinct effects. It was concluded that one foot of displacement in the spot of light on the scale corresponded with 1″ of change in the direction of the plumb-line with reference to the base of the gallows.

From these experiments the authors concluded that the instrument was susceptible of all the delicacy requisite, but that the mode of suspension was unsatisfactory.

Accordingly in 1881 they proceeded to erect a new instrument in which the support for the pendulum was a copper tube, which itself formed the envelope for containing the fluid in which the pendulum was suspended. The whole apparatus was immersed in a large mass of water, and the observations were taken from outside of the room by means of a telescope. The unsteadiness of the image was diminished, probably on account of the precautions taken against inequalities of temperature in various parts of the instrument, and because the pendulum was hung in a very confined space. The accuracy with which readings could be taken was thus increased.

Similar diurnal oscillations of the pendulum were again observed, and a similar slow change in the mean diurnal position. The authors therefore concluded that these changes are a real phenomenon, and do not depend upon changes of temperature in the instrument itself.

They also noted that there are periods lasting for several days in which the pendulum is in a state of continual agitation, so that the readings taken at a few seconds apart do not agree *inter se*, and that there are other periods of abnormal quiescence. These periods do not seem intimately connected with the external meteorological conditions, at least as far as the experiments have been hitherto carried.

The pendulum was found to be practically insensible to the effect of local tremors, such as are produced by hitting the stone support or stamping on the ground in the immediate neighborhood of the instrument. But it was extraordinarily sensitive to steady forces. If a force be applied at a point on the floor a dimple is produced in consequence of the elastic yielding of the soil, and any object on the floor is slightly tilted toward the point where the force is applied. Now when a person stood in the room at sixteen feet away from the instrument, and again at seventeen feet, the difference was rendered distinctly evident between the amounts of inclination toward the point of pressure of the stone basement supporting the pendulum in the two cases.

Although no great pains had been taken to render the instrument as sensitive as possible, it was found that an alteration of the plumb-line through one one-hundredth of a second of arc was distinctly measurable.

The second part of the paper contains an account of the work of some of the previous observers on the same subject.

M. Zöllner's instrument, the "horizontal pendulum," is described. It does not appear that any extensive series of observations have been made with it.

An account of M. d'Abbadie's work is next given. He made his observations by means of reflections from a pool of mercury, and the site of his experiments was at Abbadia, near Hendaye, in the south of France. He found that there were periods of agitation and of quiescence in the mercury, apparently without reference to any perceptible external causes. There were also gradual changes of level extending over several months, and the experience of several years showed that there was something like an annual inequality of level. There were sometimes changes through 2″ or 3″ which took place in a few hours.

At Geneva M. Plantamour has been making observations concerning variations of the plumb-line, by means of delicate levels, and has arrived at results in general accordance with those of M. d'Abbadie.

The experiments of the authors present a general confirmation of these conclusions, and show that the earth's surface is in a state of continual movement.

With reference to this continual oscillation the authors adduce an experiment which was commenced about three and a half years ago by Mr. Horace Darwin at Down, in Kent. The experiment was undertaken in connection with Mr. Darwin's investigation of the geological activity of earthworms. There are two stout metal rods, one of iron and the other of copper. The ends were sharpened, and they were hammered down vertically about eight feet deep into the soil, and they are in contact with one another, or nearly so. The ends were then cut off about three inches above the ground.

A stone was obtained like a small grindstone, with a circular hole in the middle. This stone was laid on the ground with the two metal rods appearing through the hole. An arrangement with a micrometer screw enables the observer to take contact measurements of the position of the upper surface of the stone with regard to the rods. The stone has, on the whole, always continued to fall, but the general descent can only be gathered from observations taken at many months apart, for it is found to be in a state of continual vertical oscillation.

The measurements are so delicate that the raising of the stone produced by one or two cans full of water poured on the ground can easily be perceived. The effect of frost and the wet season combined is strongly marked, for on January 23, 1881, the stone was 4·12 mm. higher than it had been on September 7, 1880. The prolonged drought of the present summer has had a great effect, for between May 8 and June 29 the stone sank through 5·79 mm.

The changes produced in the height of the stone are, of course, entirely due to superficial causes; but the amounts of the oscillations are certainly surprising, and although the basements of astronomical instruments may be very deep, they cannot entirely escape from similar oscillations.

The last part of the paper contains a discussion of the present aspects of the question, and a criticism of the various forms of instrument which have been used hitherto for the detection of small variations in the position of the plumb-line.

The authors suggest that greater precautions should be taken in the protection of the piers of transit instruments from changes of temperature, and in the drainage of the soil round the basements of the piers; they also draw attention to the disturbing effect of the weight of the observer's body. They express a hope that systematic observations of changes of level may be undertaken at a number of observatories by some instrument analogous to that with which they are working. They are still prosecuting their experiments, and they are in hopes of being able to reduce their instrument to a convenient form, so that it may not be difficult to transport or to erect.

In conclusion they state that they have no hope of being able to observe the lunar attraction in the present site of observation, but they think it possible that they may devise a portable instrument which shall be amply sensitive enough for such a purpose, if the bottom of a deep mine should be found to give a sufficiently invariable support for the instrument.

* Report of the Committee, consisting of Mr. G. H. Darwin, Prof. Sir William Thomson, Prof. Tait, Prof Grant, Dr. Siemens, Prof. Purser, Prof. G. Forbes, and Mr. Horace Darwin, appointed for the Measurement of the Lunar Disturbance of Gravity. Account of experiments by G. H. Darwin and H. Darwin, read at the British Association, York, September, 1881.

* "On an Instrument for Detecting and Measuring Small Changes in the Direction of Gravity." By George H. Darwin, M.A., F.R.S., late Fellow of Trinity College, Cambridge, and Horace Darwin, M.A., A.M.I.C.E. British Association Report. 1881.

EARTH TREMORS.*

ONE day during the past summer, at the end of a long uphill beat after the partridges, I threw myself breathless on the ground, and on my back waited for the others to come up. As they drew near, five or six strong, tramping heavily through the turnips, I was struck by the apparent tremor of the earth beneath me. It was shivering like a jelly—or I was: for a moment I was in doubt which. Spreading out my hands upon the surface and lying as close and flat as I could, I was soon made sure that the tremor was really in the earth and not in me. It grew more and more distinct, keeping time with the tramp of the walkers. When at last they reached me I told them of their Neptunian feat, and, making them jump altogether a few yards off, was gratified to find that I could thus bring about a very respectable earthquake at will. The motion was very peculiar, and I can well believe that a queasier stomach than mine would soon be conscious of something very like a *mal de terre*. We examined the structure of this skipping hill, but found nothing that helped us much to an explanation. It was mainly made up of a thick cap of gravel on a base of red sandstone, and so was not likely to contain anything like a high-arched hollow or concealed morass within.

This vivid little experience made me readier, perhaps, than some to accept the striking statements about earth shaking made by the brothers Darwin at the York meeting of the British Association. Especially was I prepared to give credit to what they quoted from the Astronomer Royal about Greenwich Hill and the Observatory. He wrote:

"In the old times of Greenwich Fair, some twenty years ago, when crowds of people used to run down the hill, I find the observers could not take reflection observations for two or three hours after the crowd had been turned out. . . . We do not have anything like such crowds now, even on bank holidays, and I have not heard lately of any interference with the observations."

There is as little foundation for the calumnious hypothesis that the observers whose reflections were thus agitated had been visiting the fair themselves as for the suggestion that the above experience of my own took place after luncheon. No, the truth is the solid earth is a very elastic solid after all, and Greenwich Hill and the Observatory and all that it contained were trembling like my Highland knoll. The *howdah* of the Atlas elephant that stands on a tortoise, is a rather rickety structure, and quakes with every jog of the Titanic beast. But is it not being tugged at by every petty planetoid, pulled from its path by every planet, heaved all awry through its yielding bulk by sun and moon in their courses? It is; but over and above these longer, graver motions there are incessant tremblings and quiverings in quick periods, measured by seconds or less. This unlooked for sensitiveness to small stresses, this incessant vibration when all obvious disturbing causes are eliminated, are the new facts that the Darwins have so strikingly brought out. How solid rock and massive piers of stone warp under heat and cold like unseasoned wood; how a wide stretch of ground may swell and rise for hours together after a little water has been poured on it; how the passage of a train miles away or the pressing of a finger on the ground near at hand may be enough to deflect the plumb line to a visible degree—these and many other new phenomena are detailed in the full and most interesting preliminary report on the Lunar Disturbance of Gravity, handed in to the Section of Physics by the ingenious brothers.

The title reminds us that, as so often in science, it was in looking for one thing that they found another. Every one knows that as the earth pulls the moon round in its monthly orbit, so, too, the moon pulls the earth and everything upon it. If a plummet be hung up right under the moon, so to speak, the earth is drawing the bob downward, the moon very much more feebly pulls it upward. The result is that the bob weighs a trifle lighter than if the moon were abolished. Thanks to the moon, the string is less severely strained. If the moon be not right overhead, but down a little toward its rising or its setting point, the bob will be a little drawn aside out of the straight and the plummet will no longer give a true plumb line. As the moon rises, crosses the sky, and sets, then the direction of the plumb line will change through a small angle. Of course, even when no moon is seen, its silent influence must be felt, and the plumb line will return to its position by the time the moon is ready to rise again. How small the change really is we may gather from the fact that with a plummet three hundred yards long, the travel to and fro of the bob could scarcely in this country reach a thousandth of an inch. This is what is meant by the lunar disturbance of the direction of gravity: and there must, of course, be a solar disturbance also, the same in kind, but naturally very much smaller in amount. To investigate these disturbances experimentally clearly calls for refined skill and very delicate apparatus; but Sir William Thomson, to whom instrumental difficulties are always but child's play, in suggesting the investigation three years ago, had in view the detection of an influence still more recondite and refined.

I have said that the moon, in pulling aside the bob of the plummet, pulls also on the earth beneath it. If the earth were perfectly stiff and unyielding, this pull could have no effect on the deflection of the plumb line. But if, as we have reason to believe, the earth yields like a great viscous mass to great stresses as well as to small ones, a hump of solid earth—a land tide—will travel round the globe in obedience to the moon's attraction. This hump in its course will pass under the suspended plummet, and the actual deflections of the plumb line as observed will no longer agree with those reckoned on the supposition that the earth is rigid. If we had an instrument, then, by which the minute aberrations of a carefully suspended pendulum, isolated as far as possible from all local disturbance, could be magnified up to the point of visibility, we should have it in our power

to settle some very pretty points in the physical theory of the world. Such an instrument, after various trials and failures, the Darwins have erected in the Cavendish Laboratory at Cambridge.

A massive stone, weighing three-quarters of a ton, is bedded in a pit upon the native gravel. It is surrounded by a trench, a foot wide, to isolate it completely from the floor and the building. The pendulum is a massive cylinder of pure copper, hung by a brass wire about a yard long, inside a hollow cylindrical copper support that rises from the stone. A tiny galvanometer mirror is hung by two fine threads, one of which is fastened to the bob and the other to a projection of the fixed support. This suspension is so arranged that any movement of the bob displaces the mirror to a much greater degree. A ray of light is sent from a distant lamp on to the mirror, and thence reflected to a scale seven feet away. The magnification resulting from this double process is something like 50,000 times. To still and quench accidental tremors, the hollow copper cylinder is filled up with a mixture of spirits and water. It is a fact, made out by Poiseuille, that a boiled mixture of gin and water is much more viscous and clogs the motions of bodies immersed in it much more effectually than either the neat gin or the simple water. Further to ward off the effects of external changes of temperature, the whole instrument is immersed in a tank of water resting on the stone; and lastly, after the precedent of the Tishbite, the surrounding trench is also filled up with water. Thus protected, the apparatus might seem sufficiently cut off from local influences, but as a fact its sensitiveness is now so great that the observation has to be carried on in another room by means of a window and a telescope. Standing in the room itself sixteen feet away, it is enough to shift your weight from one foot to the other to cause the speck of light to run along the scale. The same result follows if you press steadily with your fingers on the stone edge of the trench, but you may strike a good sharp blow even on the stone base without effect. It is the distortion of the soil by slight steady pressure that is transmitted through solid gravel and stone and shows itself as a microscopic deviation of the pendulum. Such being the case, the instrument should be delicate enough, in all conscience, to determine lunar and even solar disturbances in the direction of gravity; but, unfortunately, having got so far, we seem almost to have done too much. When regular series of observations are made it is found that the pendulum is hardly ever steady. The image on the scale dances about incessantly. The ground is never really still. Some days it may be quieter than others, and generally there is evidence of distinct diurnal periods, but the minor zigzags constantly interrupt and at times reverse for an hour together the slower march northward or southward. These tremors have been hitherto so persistent and so wildly irregular that for the present, at least, the prospect of unraveling from them the perturbations due to the moon does not seem very near. Mr. George Darwin talks of the probable necessity of building a gravitation observatory at the bottom of a mine. There, it may be hoped, the railway train and the market cart will cease from troubling, and the plummet, save for the steady paces of the moon, will be at rest. The work of examining and observing these tremors of the surface is, however, still going on at Cambridge, and already several sharp seasons of microscopic earthquake, unsuspected outside, have been noted. Sometimes a very storm of tremor breaks out for which no sufficient local cause can be traced.

Even so far, the outcome of these experiments may prove of high value to practical astronomers. The piers on which their great telescopes turn are built of solid stone, hitherto regarded as the material most insusceptible to change or disturbance. The Darwins have shown that such piers are really most sensitive to inequalities of temperature and to small stresses. They yield and warp to a most unexpected degree. Their bad conducting power is responsible for this in part, and it is fruitfully suggested that it might be well to plate the piers with copper and to swathe them with flannel. Astronomers, who, to their vexation, have to redetermine the level of their instruments from hour to hour, and who have long suspected the occurrence of microscopic earthquakes, will take note of this practical hint. They will make ready use, too, of the observation here recorded as to the effect of the observer's own weight. They will think more of the drainage of the soil around their instruments after the observation on the irregular and long-continued swelling of the ground that results from the percolation of water. Meanwhile the British Association and Cambridge may be congratulated on the new and valuable field of work thus opened out under their auspices, and especially on their having enlisted the services and energies of two workers who so worthily keep up the tradition of an honored name. —*London Times.*

COMPASS SURVEYING.

By FRANCIS E. NIPHER, Professor of Physics in Washington University, St. Louis, Mo.

THOSE who have had to do with the survey of land by means of the ordinary compass, do not need to be told that the field work is often attended with great difficulties. One of these difficulties arises from the daily swing of the needle. In the morning, at about half past seven o'clock, the north end of the needle is furthest to the east. It then moves to the west, reaching its greatest western elongation at about one or two o'clock P. M. The average daily change in the position of the needle between these hours is fourteen minutes, or practically a quarter of a degree. This angle of swing varies, however, between eight and twenty minutes, and one can never predict what the daily swing of the needle will be. Hence, if a section line should be run in the morning, and the surveyor should attempt to retrace the same line in the afternoon, he might find the final ends of the two lines twenty feet apart.

In addition to the daily change of the needle, it is also known that the average position of the needle is changing each year. The annual change at St. Louis is now about two minutes a year, but the annual change is itself subject to change according to a law which is as yet unknown. It is assumed that the annual change is the same over large areas of the country, but it is not known that this assumption is true. On the contrary, observations made at St. Louis and near Washington, in Franklin county, during the last fifty years, lead to different values for the annual change. In addition to these changes, which are due to a change in the magnetic condition of the earth, there are other errors which are due to a change in the magnetic condition of the needle. If the true variation of the needle be known at any moment, and two compasses be set for that variation, and with the needles set on the zero of the circles, the sights of the compass would not point exactly in the same direction, nor would either of them point north and south, except by merest accident. If either compass should at some later date be again set down at the same point, adjusted again to the true variation, it would not, in general, point in the same direction as before. These differences are caused by a change in the position of the magnetic axis of the needle. The *magnetic axis* of the needle always points in the direction of the magnetic meridian (when the needle comes to rest under the influence of the earth's force alone), but the magnetic axis does not in general coincide with the geometrical axis of the magnet, and its position is changed by the shocks and jostling incident to transportation and use. These changes in the position of the magnetic axis of a needle are always greatest with new needles, or those which have been freshly magnetized, and hence a needle should never be remagnetized unless it is absolutely necessary. If a line be run with an old needle, and the needle is then remagnetized, the compass set to the same variation will not in general run the same line.

These difficulties in compass surveying are the main source of the constant litigation in regard to boundary lines, and as land becomes more valuable, these quarrels will become more frequent and more expensive, until some rational method of treatment is adopted. It is not saying too much to assert that in each county there is enough money wasted each year in useless litigation over boundary lines to pay for the permanent establishment of a true north and south line which would at once settle most of these difficulties. This meridian line being once determined by astronomical methods, and properly marked on stones, and made authoritative by proper legal enactment, would serve as a standard for all time. Then if two surveyors should disagree, it would only be necessary for them to set their instruments on this line, placing the sights north and south, and they would find that the two instruments must be set to slightly different variations in order to run a true north and south line. If a surveyor should find that he could not retrace one of his own lines run the previous year, he would find by setting his instrument on the standard line, that owing to a change in the position of the magnetic axis of his needle, he must adjust to a slightly different variation. We should then learn in a short time what the annual change in the variation is at each county in the State, and should no longer be obliged to *estimate* this change.

It is certain that all this will be finally done in Missouri, as it has already been done in older States. The only question is, how long will it take the people of Missouri to learn that it will *pay* them to make use of what is well known, and has been practically serviceable in Ohio? It is only necessary for the Legislature to authorize the county courts to employ some competent person to establish such a meridian. There are certainly many persons in the State who are capable of doing such work, and the expense involved is a mere trifle compared with the great benefits to be attained.

The writer desires to say, in conclusion, to any person in the State possessing an engineer's transit, that he will at any time send instructions for the determination of the true meridian, provided that the resulting variation of the needle is communicated to him.—*Kansas City Review.*

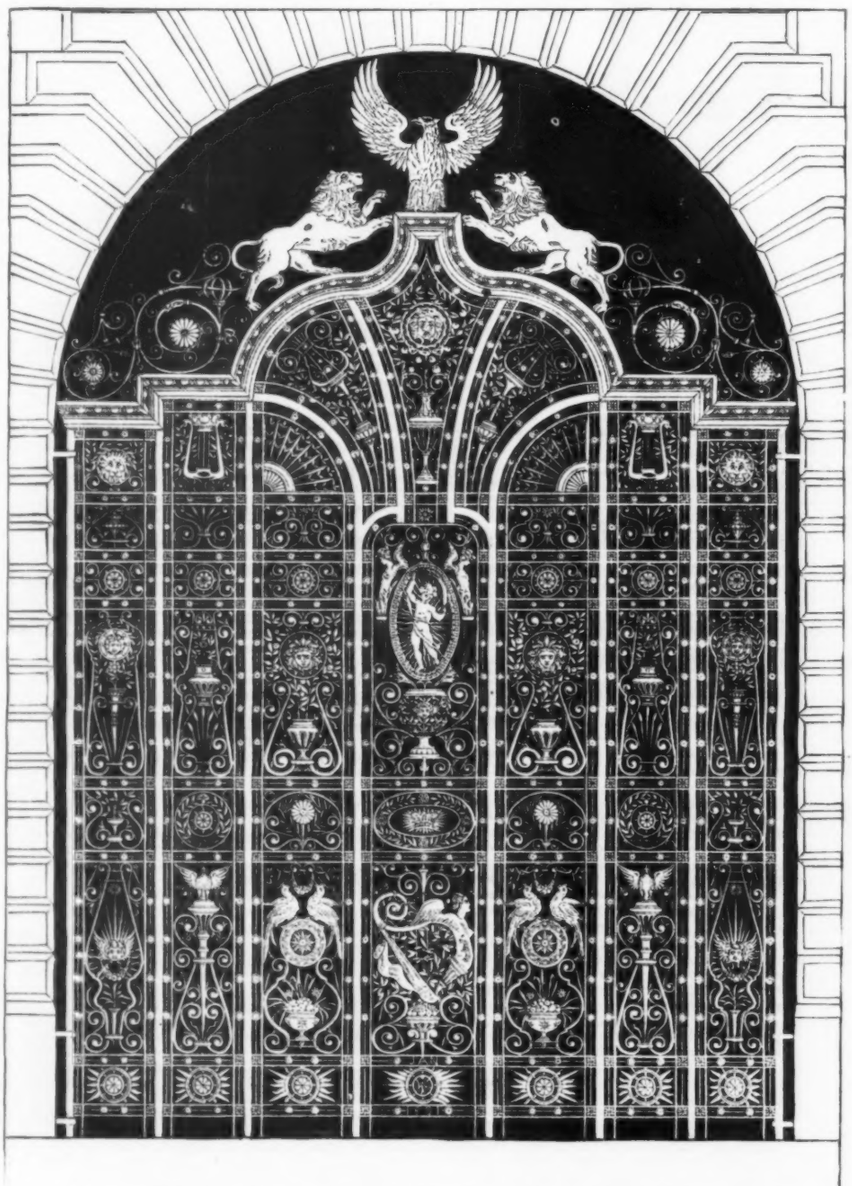
THE GALLERY OF VICTOR EMMANUEL AT MILAN.

PROMINENT among modern architectural works celebrated for good effect is the superb gallery of Victor Emmanuel at Milan, inaugurated in 1879. It is reproduced in a certain manner from the great classic forms, and reveals in all its details invention and strong imagination, presenting life in the masses, airiness in the columns, remarkable excellence of arrangement, which neither embarrass nor destroy the harmony and good effect with which they are conjoined.

The arch, which is entered from the Plaza del Duomo (of the cathedral), is 50 feet wide and 90 feet high, and is not much surpassed except by that of the Estrella of Paris.

The author and architect who constructed this famous arch and gallery of Milan is Menjoni. He has succeeded in producing a work of great effect and general fame. It is built of Carrara marble, Bareno granite, and Viggia stone.

It will be interesting to compare here the approximate dimensions of the following: The arch of Trajan, Benevento, is 43½ feet in width and 51 feet high. The arch of constantine, Rome, is 56½ feet wide and 60 feet high. The arch of the Carrousel, Paris, is 59½ feet wide and 47 feet high. The arch of Semprone, Milan, is 80 feet wide and 83½ feet high. The arch of the Estrella, Paris, is 150 feet wide and 153½ feet high.



SUGGESTIONS IN DECORATIVE ART.—IRON SCREEN.—DESIGNED BY WALTER LANE.—*From The Architect.*

THE GALLERY OF VICTOR EMMANUEL, MILAN.

DIGESTION, AND THE USE OF ARTIFICIAL DIGESTIVE AGENTS.

By J. MILNER FOTHERGILL, M.D.

As there are a great many artificial digestive agents now in extensive use it seems desirable that the general acquaintance with the digestive act should be enlarged. This is very desirable for pharmaceutical chemists and their assistants, as these digestive agents are not always purchased under medical orders; nor, indeed, is it necessary that they should only be dispensed under medical instructions: their use is too extensive for that. But as the labels affixed to these digestive agents are not themselves always accurate, indeed are in some instances actually misleading, it is very desirable that dispensing chemists should possess a sufficient knowledge of the digestive act to direct their customers as to the proper use of the artificial digestive agents they purchase, in order to secure the greatest possible benefit therefrom.

Such being the case, on the one hand, and, on the other hand, most works coming within their reach being obsolete as regards their acquaintance with digestion in its various sections, it is essential that dispensing chemists be made acquainted with more recent advanced views as to the digestive process. It will be well, then, to follow the digestive act as described by Professor Michael Foster, F.R.S., in his well-known "Text book of Physiology," it being clearly understood that the general outline is followed *here*, and no attempt essayed to discuss minutiæ or dispute points. This being clearly recognized, those who wish to go deeper into the subject can easily do so, their studies being in no way impeded by a certain familiarity with the matter.

To make a broad distinction, then, it may be said that there are three divisions of the digestive act, according to the staple elements of our food: (1) Starch; (2) albuminoids; and (3) fats.

(1.) *Starch.*—This is a purely hydrocarbonaceous substance found in numerous vegetable products, markedly in the seeds of the cerealia. It has the formula $C_6H_{10}O_5$, which differs slightly from that of sugar ($C_6H_{12}O_6$). The difference consists in a molecule of water, which, however, makes a very important difference, viz., starch is insoluble, sugar is soluble. Insoluble starch is converted into soluble sugar in the digestive act by "hydration," that is, by the addition of water. Without such change starch could not pass through the walls of the alimentary canal and reach the blood. So if starch were not insoluble it could not be stored up for the needs of the young plant, but would be washed away, and so lost. The grain of corn digests its starch as it requires it. Startling as it may seem at first sight, such is the fact.

Insoluble starch is converted into soluble sugar; that is the first operation of digestion. By this means it passes into the portal vein, and is conveyed to the liver. But if it remained sugar it could no more be stored securely in the liver than in the seed; so it is there changed back into starch—insoluble starch, as "glycogen," or "animal starch." Solution was necessary to pass it through the wall of the alimentary canal. This glycogen, or animal starch, is given off from the liver as sugar, on which the body lives. As the seed digests its stored starch as it requires, so the system takes from its store of starch in the liver according to its needs. This is the broad outline of the digestion of starch. It has first to be made soluble to pass into the blood; then has to be turned back into an insoluble form for storage; finally, it is once more made soluble for its entrance into the general circulation.

Starch, then, is converted into sugar (or a soluble matter, "dextrine") in the digestive act.

This change is achieved by the action of the saliva. Saliva contains a ferment, "diastase," which is capable of converting insoluble starch into insoluble sugar by hydration. Diastase also exists in the seed of the cerealia, and digests the starch into sugar for the wants of the germinating grain.

This diastase is active in an alkaline medium; consequently when the stomach becomes acid it is killed. Salivary diastase is operative: (1) in the mouth; (2) in the œsophagus, or gullet; and (3) in the stomach, until it becomes acid. Referring to the diagram the reader will see this is the first portion of the digestive act, marked "1. Alkaline."

A large quantity of the starch of our food is thus removed first, and so does not impede the action of the gastric juice on the other constituents.

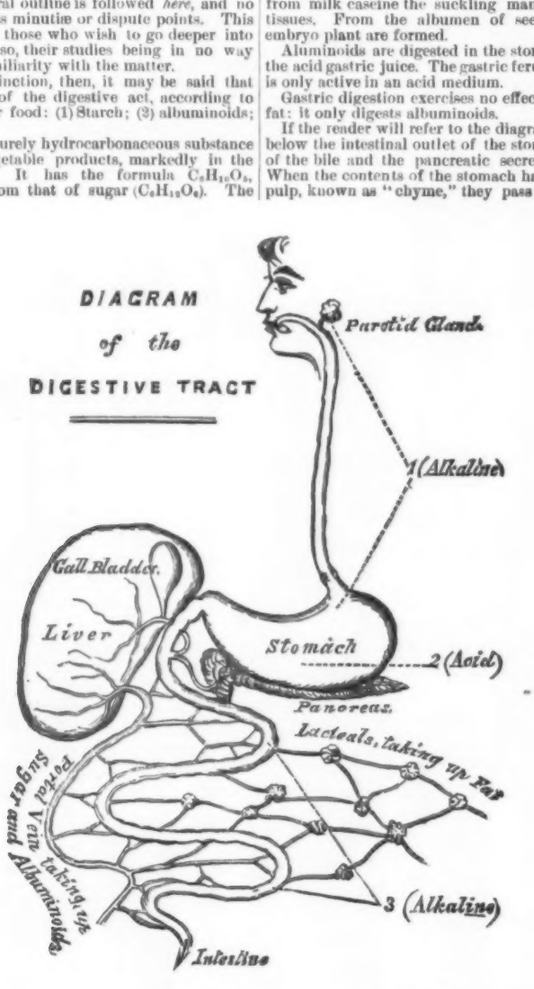
(2.) *Albuminoids.*—These are complex bodies whose characteristic is that they all contain nitrogen. Albumen, white of egg, is the type of this form of food. Hydrocarbonaceous matter may be termed "fuel-food;" albuminoids are "tissue food." The grand division of Liebig stands good yet as a broad law—as the cardinal fact to be grasped. Nitrogen interferes with oxidation, so nitrogenized matters are the constituents of tissues. If tissues were not nitrogenized they would burn equally readily with "fuel-food." This would be as inconvenient with the body as it would be in a locomotive if the ironwork burned as readily as did the coals carried in the tender. This ironwork rusts by oxidation; and the tissues wear out by oxidation; but in each case it is a slow process, which contrasts with the quick combustion to which we apply the term "burning."

Nitrogenized foods are tissue foods, spoken of generically as "albuminoids." These are egg albumen; the tissues of animals of all kinds, especially the red flesh or muscles; and caseine, animal as in milk, or as the caseine of the legumes, or pea tribe. Egg-albumen furnishes the tissues of the embryo fish, reptile, or chick, as the case may be; while from milk caseine the suckling mammal feeds its growing tissues. From the albumen of seeds the tissues of the embryo plant are formed.

Aluminoids are digested in the stomach by the action of the acid gastric juice. The gastric ferment, named "pepsin," is only active in an acid medium.

Gastric digestion exercises no effect upon either starch or fat: it only digests albuminoids.

If the reader will refer to the diagram he will see that just below the intestinal outlet of the stomach the common duct of the bile and the pancreatic secretion enter the bowel. When the contents of the stomach have been reduced to a pulp, known as "chyme," they pass through the ring (the pyloric ring) of the stomach into the upper bowel, known as the duodenum. Here the chyme becomes mixed with the bile and the secretion of the pancreas. The acid of the stomach is neutralized by the bile, so that the contents of the duodenum become alkaline.



(3.) *Fat.*—Hitherto fat has remained untouched by the digestive act, now it is emulsionized by the action of the bile. Fat undergoes no change in the digestive act beyond being converted into a fine emulsion, which enables it to be taken up by the lacteals of the intestine.

Such, then, are the three divisions of the digestive act.

But the pancreatic section is a complex fluid, containing (1) diastase and (2) trypsin. Trypsin is an energetic digestive ferment, acting upon albuminoids in an alkaline medium. Consequently we see that in the duodenum the digestive act is seen in its greatest and completest perfection, known as "chylification."

(1.) Starch is once more converted into soluble dextrine and sugar by the pancreatic diastase; and the starch unchanged by the salivary diastase, having passed through the acid stomach unaffected, is now hydrated by the pancreatic secretion in an alkaline medium into sugar.

(2.) Albuminoids are digested by the trypsin in the alkaline medium.

Albuminoids are digested in the alimentary canal by being rendered soluble by a process of hydration, so as to pass from the alimentary canal, through the walls, into the blood. Albuminoids are called "proteids" until digested; digested soluble albuminoids are called "peptones."

The peptones are taken up by the radicles of the portal vein, and in the blood are changed back to "proteids."

In the liver the albuminoid parts of our food are further elaborated to fit them for the nutrition of the tissues.

In the liver waste and surplus albuminoids or proteid matters are converted into (A) bile-acids, uniting with soda, *i. e.*, the bile which emulsionizes fat; and (B) urea and uric acid, the forms in which the nitrogenized waste is excreted by the kidneys. This destructive change is a process of oxidation. By referring to the diagram the reader will see that sugar and albuminoids are taken up by the portal vein, and carried to the liver; the fat is taken up by the lacteals, and passing through several glands, reaches the blood by the thoracic duct (not shown), which opens into the venous system at the root of the neck. The fat does not pass to the liver directly.

The indigestible and waste matters pass down the intestines to be cast out as the fæces.

Such, then, is an outline of the digestive act. Having mastered it the reader will readily comprehend the rationale and utility of the several artificial digestive agents, and will recognize what is aimed at in resort to them; and, further, what precautions are to be taken, what cautions to be observed, what errors to be avoided.—*Chemist and Druggist.*

PILOCARPIN IN DIPHTHERIA.

DR. ALFRED MULLER, of New Ulm, Minn., has communicated to the committee on diphtheria of the Minnesota State Board of Health, the following observations and extracts from a foreign article on the use of pilocarpin in diphtheria.

Dr. Franklin Staples, chairman of the commitee, in furnishing the paper for publication, observes: "While there is, seemingly, undue importance given here to the membranous exudation, or the local disease in diphtheria, the facts given by one who has had the wide experience with the disease which Dr. Muller has had, and corroborated by the foreign authorities which he gives us, are worthy of examination."

Dr. Muller writes in a note accompanying the article, which was translated for him by Dr. R. P. A. Nix, as follows: "Dr. Kuhlman, of this place, New Ulm, who has had a large number of cases, has been successful with the fluid extract of jaborandi. I have used the muriate of pilocarpin, and my success in many cases was surprising to me. I have given wine after each dose of the medicine, and a sufficient quantity of the latter to excite a profuse flow of saliva, and this was kept up until all the membranes were seemingly washed away. No unpleasant symptoms appeared in the use of the remedy."

It is a well known fact that the intensity of the febrile and other phenomena accompanying diphtheria, is, in most cases, directly proportional to the extent and amount of pseudomembranous coating of the pharynx, velum, and adjoining parts. On the other hand, the disappearance of the pseudomembranes indicates convalescence, except in those extraordinary cases in which a secondary disease or morbid condition is produced. It is evident that, in the therapeutic treatment of that disease, we must seek to remove the diphtheritic membrane in the shortest possible time, and attempt to mitigate the local inflammation and other characteristic phenomena. Among the corrodents and other remedial agents hitherto used, there is none that may be said to effect the complete destruction of the fungoid excrescence. Their application keeps the diseased mucous membrane in a state of constant irritation, which renders it almost impossible to check the production of new diphtheritic membrane.

Extracts from an article by Dr. George Guttmann, a Silesian physician, published in the Berliner Klinische Wochenschrift.

Dr. Guttmann, after studying the physiological effects of pilocarpin, employed this remedy in cases of bronchial catarrh. Its irritative influence upon the salivary glands, and the entire absence of inflammatory effects, led him to believe that the increased secretion of saliva following its use would tend to dissolve and remove the pseudomembranes in diphtheria. Accordingly, he tried pilocarpin as a remedy in this disease. The effects produced surpassed his most sanguine expectations.

In April, 1879, seven members of the same family were successively taken ill with diphtheria; three of these were afflicted with the worst form of the disease. With the second patient Dr. Guttmann used a medium dose of pilocarpin (0·05 daily) twenty-four hours. On the second day he noticed a very copious flow of saliva contaminated with diphtheritic pseudomembranes. In addition to pilocarpin, quinine had been taken internally; tannin had been applied to the diseased parts; the patient had gargled with lime water and pepsin. The other patients were treated in the same manner. All recovered in from two to four days.

Attributing this unexpected result to the use of pilocarpin, Dr. Guttmann resolved to continue studying its effects in cases of diphtheritic and laryngeal croup. He communicated his experience to Dr. Geldner, who, together with Dr. Dylensky, applied pilocarpin with equally satisfactory results. In a letter to Dr. Guttmann, dated August 2, 1880, Dylensky writes:

"Accept my heartfelt thanks for kind information concerning pilocarpin, which you were the first to use for croup and diphtheria. . . . I cannot despense with a remedy which, in the few cases which I have treated, has produced the most excellent results. Let me mention but one case. A boy of four, already quite low by anæmia and suffering greatly from dyspnœa, was brought to my office at Pitschen. An examination showed highly swollen tonsils, and pharynx thickly covered with the characteristic diphtheritic "plaques." Local treatment with the usual corrodents was impossible, as the mouth could not be opened sufficiently on account of the swelling and pain. It was interesting to ascertain whether in this case, in which death by suffocation was to be expected every moment, pilocarpin would prove beneficial. I prescribed the usual dose, and requested that the patient, in case of surviving, be brought again two days later. On the third day, the dyspnœa and cyanosis had ceased, the swelling of the diseased parts (especially of the tonsils) had diminished, the diphtheritic pseudomembranes were scanty and small. On the seventh day the boy, though weak, was beyond danger."

From April 1879, to July, 1880, Dr. Guttmann treated sixty-six cases of diphtheria. In fifteen of these cases the disease had reached such an aggravated stage that under the old mode of treatment at least two-thirds would have been considered fatal. Eighteen cases were of a mild nature, with but moderate fever. The remaining thirty three showed a considerable development of diphtheritic pseudomembranes, and were of such a character that under the old treatment at least ten per cent. would have been fatal. Pilocarpin was used internally in each of these sixty-six cases. Gargling preparations and quinine were also used with a few of the earlier patients. Each of the sixty-six patients recovered in a very short time. Of the fifteen most critical cases, thirteen convalesced in from two to five days, one in nine, and one in eleven days. The remainder (fifty-one) recovered in from one to three days.

Those patients who were placed under Dr. Guttmann's care in the earliest stage of the disease, when the pseudo membranes were as yet but loosely attached to the mucous membrane, recovered in twenty-four hours. The use of

pilocarpin produced a copious flow of saliva, which completely detached the diphtheritic membranes and infiltrations, and made the inflammation disappear. The mucous membrane, dry and of a deep red color while diseased became moist shortly after the use of pilocarpin; its color changed to a pale red, and it was in every respect reduced to its normal condition.

The same curative effects of pilocarpin were observed in other diseases involving inflammation of the mucous membrane, especially in a number of cases of pharyngitis, *angina aphtosa*, and *angina tonsillaris*. In some of these, the inflammation disappeared within twelve hours. Pilocarpin was also successfully used in several cases of laryngeal croup and laryngitis stridula.

Dr. Guttmann prescribes pilocarpin in internal doses; but he does not doubt that its subcutaneous application (by injection) would produce similar results. He adds some pepsin to the solution to act as a solvent upon plaques that may reach the stomach. For children he prescribes:

℞. Pilocarpini muriatici..... 0·02—0·04.
Pepsini..... 0·6—0·8.
Acidi hydrochlorici,..... guttæ ij.
Aquæ destillatæ..... 80·0.

Sig.—One tablespoonful per hour, day and night

For adults:

R. Pilocarpini muriatici,..... 0·03—0·05.
Pepsini,..... 2·0.
Acidi hydrochlorici,..... guttæ iij.
Aquæ destillatæ,..... 240·0.

Sig.—One tablespoonful per hour, day and night.

Should no perceptible effects be produced in twelve or twenty-four hours, the solution must be made stronger (the maximum is given above) and the doses taken at shorter intervals. After each dose a spoonful of heavy wine should be taken (children one teaspoonful, adults tablespoonful). The theory that several hours of sleep are more beneficial than all the medicaments, is entirely erroneous when applied to diphtheria. Dr. Guttmann ascertained that during several hours of uninterrupted sleep the dryness and inflammation of the mucous membrane, as well as the swelling and diphtheritic pseudomembranes, increased to a most alarming extent. At intervals of eight hours, Dr. Guttmann applies a Pressnitz (irritating) poultice to the throat. At intervals of two hours, small portions of warm milk, coffee, or soup are given alternately. The patient should frequently drink considerable quantities of cold water; the water may be cooled with ice; bits of ice may be taken into the mouth.

From July to October, 1880. Dr. Guttmann employed pilocarpin in fifteen more cases of diphtheria with unfailing success. The successful treatment of eighty-one cases within eighteen months induces him to regard pilocarpin as a specific for that disease. In an appendix to his article of October 4, 1880, he describes the following case:

The patient was a boy of seven. He was found in deep coma, breathing noisily; could hardly be roused, and immediately dropped back; coma; temperature above 40° C. (104° F.), but head, hands, and feet becoming cool from time to time; pulse full and rapid; had complained of headache, but not of pain in throat; submaxillary glands somewhat swollen; tonsils, pillars of the fauces, and hinder wall of pharynx deep red and completely covered with diphtheritic plaques. To reduce the temperature Dr. Guttmann gave *chinii muriatici* 0·5 in solution, and then the pilocarpin preparation. The next day temperature reduced; copious flow of saliva; diphtheritic layers and inflammation had almost entirely disappeared; only right tonsil deep red and showing some pseudomembranes. Four days later the patient had recovered.

The superiority of pilocarpin over all other remedies for diphtheria appears to be established by Dr. Guttmann's experience. Dilute alcohol, carbolic and salicylic acids, and the different salts hitherto employed, may destroy the surface layers of fungoids, but they seldom effect the more dangerous layers below. By the use of pilocarpin, however, these are dissolved and completely detached from the mucous membrane, and removed from the body by the saliva. The pilocarpin treatment also enables us to check the epidemic propagation of the disease. The saliva containing the dissolved pseudomembranes should be disinfected by collecting it in a vessel containing a concentrated solution of carbolic acid or some other actual disinfecting agent. The bed and clothing should be protected by wrappers. By burning the latter and disinfecting the saliva, all infectious matter may be destroyed.—*Therapeutic Gazette.*

THE TREATMENT OF SMALLPOX.

To the Editor of the Scientific American :

I wish to indorse the treatment of smallpox by Prof. Payne, as given in the SCIENTIFIC AMERICAN, of Dec. 10, 1881, and to give a few particulars of my own experience.

In the spring of 1874 we hired two young men that came from Canada on a Grand Trunk emigrant train. They had varioloid, was said to be, and did not know it. My little boy of three years was taken with it and we treated him with everything but for smallpox, until that disease broke out in a small town, Sand Lake, our post-office place (given by the same men). I then got a doctor that was familiar with the disease, who, of course, pronounced it smallpox of the worst kind, my boy being then covered with pustules. My house was full of neighbors when he gave his opinion, and we had some forty men in our employ, all boarding and living on about three acres of ground. I cleared my house of all except my family—had all hands vaccinated except myself (I was vaccinated on Staten Island when seven years old, and was then twenty-six years)—isolated my house and would not let the men leave the mill property. My wife was within three weeks of confinement, and our greatest concern was for her. The boy came out of it badly scarred, my wife was covered with pustules completely, so the soles of her feet peeled off, and she was confined at the same time. She recovered without a scar. We vaccinated the baby when a week old; it had a few pimples, and died some three months after. I had it so slight I did not know it, and nursed my family, although not a man of the forty, or their families, had anything but the lightest varioloid, and not a person died. My wife's sister was staying with us when the case was pronounced smallpox. She was taken home by her father to Grand Rapids and vaccinated; her father isolated his house, and as he owned the property, the city could not budge him; the result was the girl got well without marks although covered, and not a person took it from her.

In Sand Lake (town spoken of), they made a pest house, and out of twenty-seven cases of all kinds of smallpox and varioloid, they buried eight. I think my wife was saved by prompt vaccination which worked with the disease, and though not done soon enough in her and her sister's case, still it made the disease of a milder form, at least they do not show a single mark.

They have smallpox in Grand Rapids now and bought a pest house. They had a case in a hotel upper story exactly like the case of Prof. Payne, as to disease, and I see by the papers the doctor in charge took the man some two miles in his buggy to the pest house at midnight.

S. F.

McBride, Mich., Dec., 1881.

FRESH AIR FOR SCARLET FEVER.

THE very notable experiment which was tried by Dr. Ashby, medical officer of health for Grantham, England, in dealing with the summer outbreak of scarlet fever in that town, has deservedly attracted much attention. The plan resorted to was that of isolating the patients in tents. He prevailed upon the local authorities to erect a tent hospital on the outskirts of the town, and induced parents to send their sick there; the result was most successful. Parents availed themselves of the tents largely—their early prejudice against any such arrangement being readily overcome—the patients did remarkably well, and the spread of the disease was unquestionably much curtailed.

THE RESEMBLANCES AND DIFFERENCES OF THE TWO SEXES.

By M. G. DELAUNAY.

THIS is the title of a paper published in the *Revue Scientifique* for September 3, 1881. It has special interest as presenting the most complete review of the differential characters of the sexes of the human species which has appeared. The author's conclusions are curious and instructive. We give a necessarily much abbreviated synopsis.

The author commences by showing that the female is much the larger and more powerful in most of the lower animals. He cites the Cephalopoda, certain cirripeds, most annelids, most insects—as Hymenoptera and Lepidoptera. Among vertebrates the female is the larger among many fishes and reptiles. Among the higher *Vertebrata*, the relations are reversed. In birds, except in a few birds of prey, the male is the larger, and this is universally the case among *Mammalia*. This superiority of the male sex consists in the following points: In the male the phenomena of nutrition are more intense. The blood is denser and redder, and contains more red corpuscles and hæmoglobine, and fewer white corpuscles and less water. Malassez has proven that man has a million more red corpuscles in a cubic millimeter of blood than woman. Man eats more than woman. The public charities know that it costs more to feed a boy than a girl. Nevertheless though she eats less, woman eats more frequently. In the asylums the women take food from the table, thus doubling the number of their meals.

Respiration is more intense in man than in woman. In a man and woman of equal size, the man has a demiliter more pulmonary capacity.

Man absorbs more oxygen, though he breathes less frequently. According to Quetelet, between the ages of fifteen and fifty, woman has one inspiration per minute more than man. At all ages man excretes more carbonic acid than woman. The temperature of man is more elevated than that of woman. In the circulation, the blood-pressure is stronger in man than in woman, but the pulse is less frequent. The differences in several animals are as follows: in the lion, 18 pulsations per minute; the ox, 10; the sheep, 12; and 10 to 14 in man. The anatomical pre-eminence of the male is especially in the functions of animal life.

The skeleton of woman is lighter in proportion to her total weight than that of man. It has been discovered that the male skeleton contains more inorganic matter than that of woman, and more carbonate of lime and less phosphate of lime. The woman uses the right side less than the man. According to Livon, the left shoulder blade is larger than the right in woman, as in the inferior races. Broca found that the length of the clavicle, as compared with the humerus, is greater in woman than in man, as it is greater in the negro than in the white race. Man, as is well known, is larger than woman, and also more heavily built, although the adipose coat of woman frequently gives an opposite impression to the observer. Among the Indo-European nations, woman is more prognathous than man.

The difference between the voices of men and women are perceptible among many of the higher animals. The inferiority in muscular energy on the part of women amounts to one-third the force exerted by the male. Muscular movements are more precise in man; this is seen in pianists, the best of whom are men.

The skull is more voluminous in the male. Wiesbach found its cubic contents in German women and men to be as 878 to 1,000. Morselli compares the capacities as 85 to 100. According to Broca, the difference in favor of man is 150 centimeters for the French and 211 for the Parisians. In woman the skull is generally more elongate and less elevated.

The brain of man is heavier than that of woman, not only absolutely but relatively. The size of woman to that of man being as 927 to 1,000, the weight of her brain is to that of man as 909 to 1,000. When of equal size, the brain of woman is much less heavy than that of man. The mean weight of seventeen male brains exceed that of as many brains of females of the same size by 172 grammes. There are also differences of conformation. According to all anthropologists (Broca, Wagner, Huschke), the frontal lobes are less developed in woman. Huschke found fifty-four cubic centimeters difference in favor of man. On the other hand, the occipital lobes are more voluminous in woman than in man. According to Wagner, the female brain is always in a more or less embryonic condition. Some anatomists think that the right brain is more developed in woman and the left in man. This will explain why, in passing, man generally chooses the right hand, and woman the left.

After a discussion of the metaphysical qualities of the sexes, the author presents a view of their peculiarities in different races. His conclusions are as follows:

"The pre-eminence of the female sex, only seen in certain inferior races of men, and in the infants of the higher races, marks an inferior stage of evolution.

"It is the same with the equality of the sexes, which is only seen in little developed individuals, as inferior races and species, young persons, the aged, and in inferior classes of society.

"On the contrary, the pre-eminence of the male over the female represents a superior phase of evolution, since it characterizes superior species and races, adult age, and the superior classes of society.

"From the moral as from the physical side, evolution appears to have progressed from a state of superiority of the female to that of the male sex; and the stage of equality represents an intermediate stage."—*American Naturalist.*

A NEW GAS KILN.

A NOTEWORTHY advance in the direction of utilizing gas for trade purposes has recently been made by Messrs. Thompson Bros., of Leeds, a firm principally occupied in glass-staining and similar work in glass and porcelain. It is well known that in ornamental glass and tile work, which has of late become so fashionable in connection with the modern high-art revival, the firing of the goods is a most important feature. From the early days of the trade this has been done in "muffles," or simple ovens fired by coal, or, more recently, by coke. The operation of firing a charge of glass or tiles by this method was tedious, costly, dirty, and uncertain. It took several hours to bring the muffle to the right heat, and then the labor of attending to the goods, bricking up the ovens, and other necessary devices, was disagreeable and prolonged. The cost of fuel was considerable, as so much of it was devoted to heating a mass of brickwork, and in other ways but indirectly connected with the work required to be done. There was, too, a constant risk of spoiling the color of the work by the dust and fumes from the fire; while, when coal was used, the smoke from the oven chimneys was highly objectionable to the residents in the neighborhood. The uncertainty of the work was, after all, its greatest drawback. It was seldom that a charge of glass or tiles, howsoever carefully packed in the muffle, was equally burnt in every part, and much work was in consequence usually wasted, so that a liberal allowance for accidents in firing had always to be made in estimating the value of glass or porcelain painted work. The same remarks will apply with equal force to the annealing of glass, etc.

Messrs. Thompson claim to have remedied all these defects, and to have rendered the work of the glass stainer and tile painter easy and certain by the introduction of their patent gas-kiln, many examples of which have already been erected in this country and abroad, two of them being now in full work in London. We have had an opportunity of inspecting one of these, and examining the work done with it at the glass painting works of Messrs. Britten & Gilson, Union street, Southwark, where, although but newly erected, it has quite supplanted the old muffle. The construction of the new kiln is so simple and apparently obvious in every part, that it might have aroused surprise to find it treated as a great and unheard-of innovation, but for the remembrance that it is always more difficult to invent a simple than a complex apparatus. Without going into the details of the kiln, which would possibly interest only glass painters and followers of the allied arts, it may be briefly described here as a rectangular chamber—the one in Southwark measures four feet by three feet—covered by an arch of very slight rise, the whole being built of fire brick, and closed in front by a wrought-iron double door, provided with sight holes. A row of straight Bunsen burners projects inside along each side of the oven at a few inches below the roof, which is pierced in the center with several peculiarly arranged flues. The goods to be fired are placed on a flat table, carried on a truck which is run into the oven through the doors in front, the top surface being therefore near the line of burners. The appearance of the interior of the kiln above the table, when the gas burners are all alight, is very striking. The Bunsen flames just meet in the center of the roof, and when the brickwork is well heated, and the chimney draught checked, the flowing convolutions of the flames which then appear to fill the interior space are peculiarly illustrative of the causes of the benefits of gaseous firing. The heat evolved is very great, and is, of course, perfectly under control, and the operations going on inside the kiln can be easily watched. As a result of the working of the kiln at the Union Street factory, the following facts are worth recording. The kiln burns twelve superficial feet of glass at each firing, which occupies one hour, and costs as follows:

Gas consumed, 235 cubic feet, at 2s. 10d. per 1,000 feet.....	0s. 8¼d.
Labor of one man, say one hour.....	0 6
Cost per firing.....	1s. 2¼d.

The kiln can easily be fired six times in one day, at an outside cost of 7s. 3d. The work done will be therefore seventy-two superficial feet of glass fired, which, at the prevailing trade price of 6s. per foot, amounts to £1 16s., less 7s. 3d. working expenses; leaving £1 8s. 9d. gross profit, or £8 12s. 6d. per week of six days. The old muffle was fired with gas coke, costing every time as follows:

Coke for fuel.....	1s. 9d.
Labor, five hours (at least), at 6d.....	2 6
Cost per firing.....	4s. 3d.

This muffle could only be fired once daily, and as it did an amount of work at each firing equal to the gas kiln, this twelve superficial feet of glass would be charged at 6s., from which, deducting the 4s. 3d. expenses, the gross profit per day is only 1s. 9d., or 10s. 6d. per week. The profit in favor of the gas kiln is therefore £8 2s. for a week's full working, taking existing prices for the work done. It must be remembered also, in estimating the economical advantages of the new system, that the work is very much better done than was possible in the old way, and nothing but sheer neglect will spoil the process. We have not included in the foregoing computation the cost of capital, repairs, etc.; but it may be taken that all such charges show greatly to the advantage of the gas kiln.

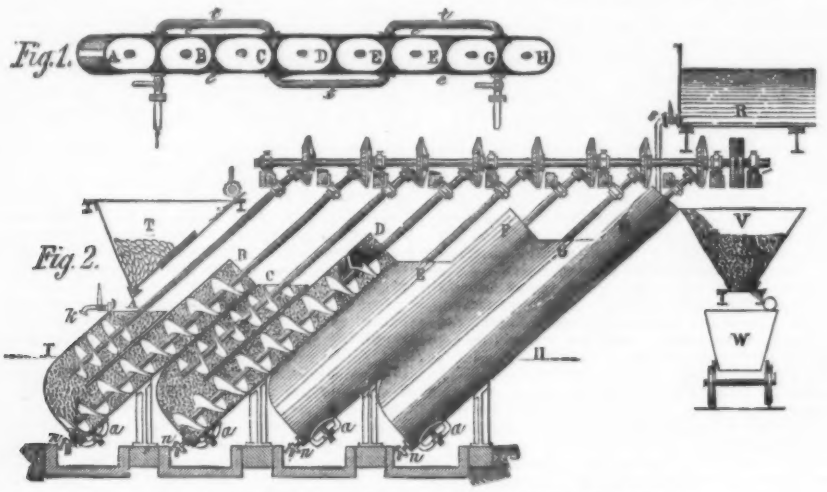
It is stated that another of these kilns just put to work at the Whitefriars Glass Works completes the operation of firing in thirty-five minutes, with a consumption of two hundred feet of gas. This difference is attributed to a higher pressure, the supply being in the latter case taken from a trunk main. It should be remarked that no artificial means of increasing gas pressure or employing a blast are used in Messrs. Thompson's kilns, which work perfectly at a pressure of about eight-tenths at the point of ignition.

The extent to which the adoption of these kilns is likely to affect gas consumption is made evident by the fact that arrangements are now in progress for laying a special ten-inch main into one large factory in South London, where special ovens are being erected for enameling and peroxidizing iron goods. An abundant supply of gas during the process of firing is the sole condition of success in the working of these kilns. As we have already stated, the invention of Messrs. Thompson Bros. is primarily intended for use in the glass staining and tile painting arts, but its application is by no means limited to these industries. Any trade process wherein roasting, baking, tempering, or annealing is

employed can also be usefully served by gas; and Messrs. Thompson are actively engaged in introducing their ovens for various purposes, from enameling gold and silver down to baking bread. The kilns can be seen in operation at Messrs. Thompson's works in Leeds, and at Messrs. Britten and Gilson's works in Southwark. The approaching exhibition of the Fog and Smoke Prevention Committee of the Health Society, at South Kensington, will also contain a kiln in full operation.—*Journal of Gas Lighting.*

LARGILLIERE'S APPARATUS FOR CONTINUOUS DIFFUSION.

THE diffusion apparatus of Mr. Largilliere, of Boistrancourt (France), shown in the accompanying figure, is composed of a certain number of receptacles, A, B, C, D, E, F, G, and H, coupled in pairs. The slices of beets to be exhausted fall from the hopper, T, into the receptacle, A, in which they ascend through the action of the screw therein; and the screw of the second cylinder, B, then carries them upward and empties them into the third cylinder, C. The operation continues in the same manner until the cylinder H, is reached, and from this the slices pass into the hopper, V, from whence they are carted away by the wagon, W. The water, necessary to extract the beet juice flows from the reservoir, R, through the pipe, *s*, into the cylinder, H, and afterwards traverses the apparatus in a direction opposite to that of the movement of the beets, and finally leaves the first cylinder, A, through the cock, *k*. For the purpose of cleaning the apparatus the latter is provided with man holes, *a*, and



CONTINUOUS DIFFUSION APPARATUS.

purge cocks, *n*. All the cylinders are heated by steam jackets, *e*, connected one with another by means of tubes, *t*.

UNION BY PRESSURE.

ABOUT two years ago several experiments were made by Walthere Spring in regard to joining substances by pressure, the pressure used being, in many instances, as high as 30,000 atmospheres. Nitrate of potash and nitrate of soda were compressed from the state of powder into small hard blocks, which were more solid than if made by fusion, and the original separate particles composing them could not be traced.

The possibility being thus proved of uniting solids by pressure, it remained to extend the experiments over a large number of substances, to make trials in a vacuum, and to ascertain the effect of temperature on the readiness with which the union could be produced. In the preliminary experiments of Mr. Spring, the compression was effected by a ram working in a steel cylinder by means of a screw and hand lever. The solid blocks produced were, however, very difficult to get out whole, and the pressure exerted upon them could only be roughly estimated. In the late experiments, therefore, the pressure was produced by loading a lever with dead weights, and the cylinder or die in which the substances were compressed was composed of two separable parts, held together tightly at the top by a nut, the lower part fitting into a recessed base plate; they could thus be taken apart for getting the compressed block out without injuring it. The die was covered by a gun metal bell or air-tight receiver, from which the air could be exhausted for experimenting in a vacuum. The ram, loaded by the lever, passed into the cylinder through a stuffing box in the top of the bell. It was found, however, that the pressure could not be increased beyond 10,000 atmospheres. 15,000 lb. per square inch, the steel ram itself crushing at this limit, being replaced by another after each operation. The presence or absence of air had scarcely any perceptible effect in the experiments and on this account, together with the fact of the crushing of the ram, the old apparatus with the screw was ultimately adopted again.

In regard to trying the substances in a heated state, it should be observed that those giving good results without it were not tested in that way. Eight metals were tried by Mr. Spring, and all except zinc were compressed at a temperature of 57° Fah. From lead filings, compressed in a vacuum under about 2,000 atmospheres, a block was obtained as solid as if cast by melting, and the microscope failed to detect the slightest trace of the original constituent particles. At 5,000 atmospheres the lead would no longer stand under the ram, but oozed out through all the joints like a liquid, allowing the ram to be driven down to the very bottom of the die. On opening the die, the fine flakes of lead leaf had exactly the appearance of sheet lead produced by rolling, conformably with the result of M. Tresca's experiments on the flow of solids. The specific gravity of the compressed lead was found to be 11·5 instead of 11·3. Bismuth, though so brittle and easily pulverized, yet joins again readily under pressure; a block compressed from fine powder under 6,000 atmospheres breaks with a crystalline fracture, just as though it had been cast; and the same holds true for almost all the other substances tried. Tin filings join perfectly under 3,000 atmospheres; at 5,000, the tin begins to flow out through the joints of the die, but soon stops, at 5,500 begins again, and again stops; and so on up to 7,500 atmospheres, under which pressure the flow becomes continuous.

Zinc filings join perfectly under 5,000 atmospheres, and under 7,000 the compressed block barely begins to flow. Joining less readily than the other metals already cited, zinc forms a good illustration of what takes place also in the compression of all the other substances tried, proving that union depends solely on the closeness with which the particles are brought into contact. Under no more than 26·3 atmospheres pressure, zinc filings do not join. Under 700 they so far join as to come out of the die in a block, which, however, breaks very easily and then falls to dust; a microscope shows distinct spaces between the filings in the block. Compressed under 2,000 atmospheres, the block will hold together under the file, but breaks under the hammer; its fracture still shows spaces between some of the filings, though much fewer, while others of the particles are now clearly seen to have become perfectly joined. With 4,000 atmospheres, very few interstices can be detected; and with 5,000, the block is perfectly solid throughout, and stands gripping in a vice and filing and hammering like a block cast by melting. A trial was also made of compressing pulverized zinc at the temperature at which it is most malleable, namely, about 266° Fah. It then joins still better, and the block breaks with a crystalline fracture.

Aluminum joins too weakly under 4,000 atmospheres to stand filing; under 5,000 it stands filing, but not hammering, while with 6,000, it joins perfectly and becomes malleable. The same holds good with regard to copper. In the case of antimony, the trial was not made with filings, but with the finest powder possible, in order to ascertain what pressure would reproduce the metallic luster which is lost in the state of powder. With 5,000 atmospheres, the luster reappeared on the surface of the compressed block, but its center remained pulverulent and dull gray; under higher pressures the luster penetrated deeper and deeper in from the surface. Spongy platinum begins to join under 5,000 atmospheres, with metallic luster on the surface; but the block is friable and the fracture dull, and higher pressures do not produce so perfect a union as in the preceding instances. The readiness with which these metals join is seen to be inversely as their hardness, and as the hardness generally diminishes with rise of temperature, it may be concluded that the softer a metal becomes by heating, the more readily will it weld, just as iron gets very soft before melting, and welds easily.

Other experiments were made with metalloids, oxides, sulphides, salts, and carbon compounds, which, however, will not be considered here, those given above being of greater practical interest.

OUR SWEETS.

IT cannot be a mere matter of chance that substances used as foods by men and animals are some of them sweet and others acid, or that some are sweetened with sucrose (cane sugar), others with glucose (grape sugar), and still others with levulose (fruit sugar). There is a wonderful adaptation of means to ends throughout nature. The sweet sensation is generally agreeable, as has been before stated, but it must be modified and adjusted, else it would become repulsive. If our fruits were all sweetened with pure cane sugar in differing proportions, they would lack a certain zest, due to a peculiar sweetness which they now possess; or if our grapes did not form an exception to other fruits in the method of sweetening, they would not be the delicious fruit so universally esteemed. Apples, pears, peaches, and most other fruits are sweetened with levulose, or what may be regarded as a mixture of sucrose and glucose; and differing varieties hold unlike proportions, giving in conjunction with malic acid and certain essences the nice shades of flavor observed. The manufacture of sugar is not set up in fruits until the period of maturity is nearly or quite reached, and then the process is usually a gradual one.

The grape vine and fruit do not possess the power of grouping the atoms of hydrogen, carbon, and oxygen so as to form molecules of sucrose; the result of their work is confined to glucose. Hence a grape is never excessively sweet, or it does not reach a degree of sweetness beyond what glucose can furnish. If a grape were a solid mass of sugar it would not be very sweet, as the sugar is incapable of conveying to the taste any intense sensation. Every one who has tasted old or well dried raisins has observed the hard lumps of sugar which frequently form of considerable size under the skin covering. These are lumps of glucose which result from the evaporation of the moisture in which it was held in solution in the grape. These lumps are deficient in sweetness, as has been observed from the earliest times. If this substance was supplied in large quantities from grapes or raisins, it would sell at a low price in the market. If a grocer sold it for pure sugar (cane sugar), it would probably come back to him again, and he would rightfully be charged with fraud. No shrewd dealer or manufacturer would sell it by itself as sugar, but those dishonest in the trade would mix it with cane sugar, and thus dispose of it with less risk of exciting suspicion. This is now a form of fraud of enormous magnitude, as will be presently shown.

During the wars of Napoleon I., early in the present century, he established the famous Continental blockade, by which all products of England and her colonies were excluded from the markets. This of course made sugar scarce and dear in France, and stimulated search for products which might be substituted. The grape crop of France was enormous, and as commerce was destroyed it was useless to make wine; so attention was turned to extracting the sweet principle of grapes. Sirups and sugars were made from grape juice in large quantities, and Napoleon ordered it to be used in the palace as an encouragement to its production. He issued several decrees in regard to its manufacture, and the celebrated chemists of the time, Proust, Berthollet, Parmentier, and others, were kept busy striving to perfect the products. Montalivet, the great minister of the interior in Napoleon's cabinet, in one of his reports, states that it has been ascertained that the grape-sugar equivalent of cane is a little over two and a half to one. This is not far from correct.

Thus it is shown that the chemists of France were making glucose more than seventy years ago from grapes, and if they had known that it could be made as well from potatoes, corn, or any other cheap substance holding starch, the discovery might have retarded the great progress that soon followed in producing cane sugar from beet juice.

It was as early as 1747 that Margraff made his experiments showing that beets contained sugar, but it was not until Achard, the son of a French refugee in Prussia, took up the subject, and published the astonishing results of his researches, that it excited public attention. The difference between the two forms of sugar, that from grapes and that from beets, was easily seen, and Napoleon's attention was called to it by his corps of illustrious chemists. He immediately gave himself to the work of creating and perfecting this new industry, and in 1812 he had the satisfaction of learning from the reports of his minister of the interior that 334 factories in the empire were producing annually 7,700,000 pounds of beautiful cane sugar from beets. This seems almost like the work of magic, and illustrates the greatness of the man whose power was felt in every part of the civilized world.

The early attempts to extract sugar from beets in Napoleon's time were made subjects for fun and ridicule. The Emperor himself did not escape the lampoons of the wits of the age. A caricature was exhibited in Paris, in which the Emperor and the baby King of Rome were the prominent characters. The Emperor was represented as sitting in the nursery with a cup of coffee before him, into which he was squeezing a beet root. Near him was seated the King of Rome voraciously sucking a beet root, while the nurse, standing near and steadfastly observing, is made to say to the youthful monarch, "*Suck* dear, *suck;* your father *says* it is sugar."

In manufacturing glucose from corn, the process is, first, to separate the starch from the other constituents of the grain, by simple mechanical means; and then, secondly, to act upon the starch with dilute sulphuric acid (oil of vitriol). When thick gelatinous starch is boiled for a couple of hours with this acid, a curious transformation takes place; the milky paste first changes to a fluid as limpid as water, and as the change advances this acquires a sweet taste, which is masked by the presence of the acid. If we now saturate the solution with some earthy carbonate, marble dust for instance (carbonate of lime), the acid is removed, and a sweet solution remains, which, after purification, may be evaporated to a sirupy liquid, or by still further manipulation, converted into a white solid, which is grape sugar. This is the whole process for making "sugar out of corn," and it is simple enough. In this chemical transformation nothing is absorbed from the air, and no other substances but dextrine and grape sugar are generated, and the weight of the sugar exceeds that of the starch employed. What is still more wonderful, the acid used undergoes neither change nor diminution; it is all withdrawn in its original amount after the boiling is completed. If it could be withdrawn in its clear, uncombined state, one carboy of oil of vitriol would serve to change all the corn grown in the United States into grape sugar. Theoretically, one pound of corn ought to make a pound of solid glucose, but in practice it does not quite do this. The cost of solid glucose to large manufacturers cannot exceed three cents a pound, and it may fall considerably below this.

Nothing can be more paradoxical to the popular reader than the statement that sugar is produced by the use of one of the most powerful mineral acids known to chemists. To explain clearly and fully the chemistry of the reactions involved in the process would require more space than we have at command; and also, to understand the nature of the changes, more scientific knowledge would be required than is possessed by ordinary readers.

Glucose is a cheap, imperfect substitute for the genuine sugar of commerce. It is not a poison when well made, and, as regards its healthfulness, it may not be much more deleterious than ordinary cane sugar. Still, it does produce and aggravate dyspeptic symptoms, and by its proneness to set up fermentative processes its use causes flatulency and painful affections of the bowels.

What becomes of the millions of pounds of glucose manufactured in the Western States every month? It is used mostly as an *adulterant* in the manufacture of table sirups, and in adulterating the dark, moist sugars used largely by the poor. Its next largest use is in the manufacture of candies. All soft candies, waxes, taffies, caramels, chocolates, etc., are made of glucose. Children are therefore large consumers of this substance; the honey bees also, are fond of it, and will carry it away by the ton, if placed within their reach. The honey made from it is no better than the pure glucose, as it is stowed away in the comb without change. Human ingenuity, it is stated, has reached the point of making honey and storing it *in the comb* without the mediation of the bee; therefore we can now dispense with its services. By appropriate machinery a nice-looking comb is made out of paraffine, the cells being filled with glucose sirup, and this factitious honey is warranted true white-clover honey from Vermont.

The beautiful clear white sirups found on our breakfast tables, and used as an agreeable adjunct to our waffles and buckwheats, are largely composed of glucose. A mixture of true "sugar-house" sirup, with glucose sirup, in proportions of five or ten per cent. of the former to ninety or ninety-five per cent. of the latter, constitutes the high-priced "maple drip" of the grocers. A Western chemist reports the results of recent analyses in which adulterations amounting to from five to fifteen per cent. of glucose were found in various popular brands of sugars.

In this brief consideration of the nature and uses of a comparatively new article of manufacture, the astonishing fact is disclosed that this year more than 12 million bushels of corn have been manipulated to produce an article employed almost exclusively as an *adulterant* to one of the most common

and important constituents of food. It is a reprehensible form of fraud, and should be arrested by laws similar to those which govern the sale of the "oleomargarine" compounds. Every package of this sugar should be stamped *glucose*, and sold as such; and every mixture made with it should be accompanied by a statement, stamped upon the vessels which hold it, giving the exact percentage of glucose contained in the adulterated sugar or sirup. A law similar to that which is found on our statute books regulating the sale of fertilizing compounds would be effective, if energetically enforced. The loss to purchasers in the glucose sirups is enormous, as the quantity required to sweeten substances is at least twice as great as when cane sugar is employed, and the use of this quantity of the agent renders it deleterious to health. The attractive appearance of the sirups, which are white and clear, gives them a wide sale at high prices, and all consumers of sweets in the country are victims to a form of fraud which deserves the prompt attention of our lawmakers.—*Boston Journal of Chemistry.*

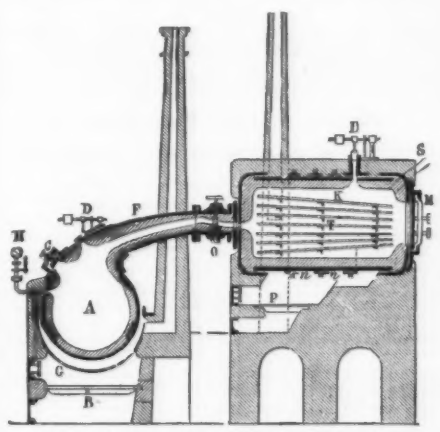
APPARATUS FOR TREATING WOOD WITH OZONIZED OXYGEN.

THE object of the process invented by Mr. Rene, who is a piano manufacturer at Stettin, is to free the wood designed for pianos from the resinous and fatty matters that it contains, by the action of oxygen, heated to a moderate temperature and ozonized by the passage through it of a series of electric sparks. In this way these matters are decomposed, and the wood is prepared so as to render it better fitted to receive the vibrations of the strings, and consequently to give greater resonance. Besides this, the process gives young wood the qualities of old, which alone up to the present time it had been possible to use in pianos.

Oxygen, especially when it is heated and ozonized by electricity, entirely decomposes the fatty and resinous matters contained in wood.

It is a well-known fact that wood, which has been submitted for a very long time to the action of air, is well fitted for the manufacture of instruments and especially that of sounding boards. It is, then, not surprising that pure oxygen should act in a much more complete and rapid manner.

The wood to be prepared must first be placed in a hermetically sealed receptacle, in which it should be so arranged that the oxygen can have access to its entire surface. After this the air is exhausted by means of a pump and the oxygen is introduced in its stead. The latter is then transformed into ozone by a current of electric sparks, while at the same time the reservoir is submitted to heat. The operation takes from twelve to twenty-four hours or longer, according to circumstances.



APPARATUS FOR PREPARING WOOD.

In order to remove the dampness and to cause the resin to start out of the wood, the reservoir is submitted to strong heat for about twelve hours before transforming the oxygen into ozone. After the wood is dried, the hot air is allowed to escape by opening the safety-valve; then, after the wood has been submitted for a few hours to the action of the ordinary atmosphere, the reservoir is hermetically closed, slightly heated, and finally exhausted of its air. Then the oxygen is introduced and transformed into ozone, by means of a powerful electric current.

The apparatus, which is shown in the accompanying cut, consists of two principal parts, viz., a retort, A, for preparing the oxygen, and a chamber, K, which may be hermetically sealed, and in which is placed the wood to be treated. The iron retort is provided with several safety-valves, D, with a pressure gauge, M, and an aperture, C, for charging, which may be closed hermetically. This retort is partially surrounded by masonry, like a steam-boiler, over a fireplace, B. Beneath it there is a perforated steel plate, G, designed to prevent a direct contact of the retort with the flames. The entire apparatus is protected against the action of the disengaged oxygen by a lining of refractory bricks, and the retort ends in a neck, F, which may be entirely closed by a valve, O. This neck leads the oxygen into a rectangular iron boiler, K. The boiler is arranged like the retort, carrying likewise a safety-valve, D, and being partly inclosed in masonry over a fire-place, P; and, in order to obtain uniformity of heating, there are flues running over almost its entire lower part. These flues afterward divide into two ascending pipes which run toward the retort on both sides of the boiler, and then rise toward the chimney, where they again unite. The boiler is lined internally with fire clay, and contains at different heights, perpendicular to its longitudinal axis, very light angle irons which serve as supports to the planks of wood, T, and which are arranged in such a way that the so proposed planks, spread out in a fan like manner toward the end of the boiler, situated near the retort. At the opposite end there is a wide aperture, M, which serves for the introduction of the wood to be prepared, and which may be hermetically closed. In order to avoid weakening of the boiler, this aperture does not extend from the top to the bottom; and it is for this reason that the wood is arranged in a fan-like manner. The lateral walls of the boiler are further strengthened by three double angle-iron rings.

In order to transform the oxygen into ozone, the two conducting wires, S, of a strong battery or induction apparatus traverse the masonry and the boilers through insulators (which here are glass tubes), and enter the chamber, K, where they terminate in platinum points, placed at certain distances from each other.

OXYGEN FROM BLEACHING POWDER.

HITHERTO oxygen when required in anything like a pure or undiluted state—as for the lime light, oxyhydrogen blowpipe, etc.—has been obtained almost exclusively from potassium chlorate by heating that salt to decomposition in the presence of peroxide of manganese.

Pure potassium yields nearly one-third its weight of oxygen. The commercial is never chemically pure, however, and in practice it rarely yields more than twenty-three gallons a pound (at 60° Fah. and normal pressure) of gas, the latter frequently containing much chlorine.

The salt costs at wholesale twenty-five cents a pound, and requires to be mixed with about one-quarter its weight of peroxide of manganese, costing eight cents a pound, thus making the cost of the gas for materials alone about nine cents a cubic foot.

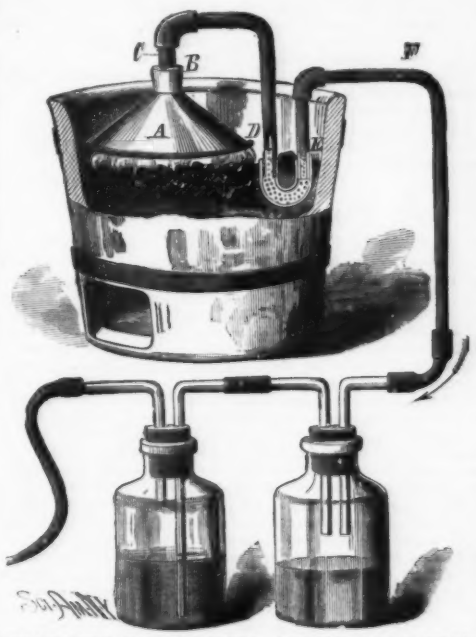
Where economy is considered, common bleaching powder or chlorinated lime can be made to profitably take the place of the more expensive salt as a source of oxygen.

An average sample of bleaching powder (fresh) contains at least twenty-six per cent. of calcium hypochlorite. This substance when heated to the boiling point of water splits up into calcium chloride and calcium chlorate. If the heat is increased to low redness the chlorate is decomposed into calcium chloride and oxygen.

During the elevation of temperature some hypochlorous acid is apt to pass off; but if the apparatus is so arranged that the gas is forced to pass over or through a small quantity of heated lime it is arrested, decomposed, and the oxygen liberated—oxygen and steam only passing over.

In a series of late experiments with an apparatus similar to that described below, the yield in oxygen per pound of common commercial bleaching powder, costing one and three-quarters cents, averaged four gallons, making the cost of materials for oxygen from this source about three and one-quarter cents per cubic foot, as compared with nine cents where potassium chlorate is used.

The gas after passing through the wash bottles is perfectly odorless and nearly pure.



APPARATUS FOR MAKING OXYGEN GAS FROM BLEACHING POWDER.

Where the gas is required in small quantities, a few cubic feet at a time, the following simple and inexpensive apparatus answers very well:

The retort, A, is made of common sheet iron, doubly lapped and riveted. The short neck, B, is slightly flaring so as to admit of the luting in of a piece of inch steam pipe. This pipe, C, is connected by a screw cap or elbow with a longer piece of similar pipe bent somewhat and extending downward two or three inches below the bottom of the retort, where it is joined by a U cap at its lower end with a third piece of iron pipe extending upward above the bottom line of the retort. A fourth piece of pipe is connected with this latter at right angles for convenience of attachment to condenser and wash bottle. The space from D to E in the tube is loosely filled with fragments of quicklime, each somewhat larger than a pea.

Two or three pounds of the chlorinated lime having been put into the retort, the pipe, B, is loosely inserted in the neck and the joint made tight with a stiff luting of clay or plaster of Paris. The retort is then placed on a charcoal or other moderate fire, the portion of the pipe containing the lime being in the fire. Connection is made with the condenser and wash bottle as soon as steam begins to come over, and as soon as the air in the apparatus has been displaced connection is made by rubber tubing with the gas bag or reservoir.

The moisture in the heated substance first passes off together with some gaseous matter, the latter being decomposed by the lime; then as the temperature rises and approaches low redness oxygen is rapidly disengaged, and if the fire is good ten minutes' heating will suffice to exhaust the charge.

The stop-cock at bag or reservoir having been closed, the retort may be slipped out, another similar one already charged put in its place, and the operation repeated if desired.

The chloride of lime should not be too moist when placed in the retort, or the charge greater than will loosely cover the bottom of the vessel to a depth of one and one-half inches.

If a sudden pressure greater than the delivery pipe can relieve is developed in the retort the luted joint acts as a safety valve.

The sheet iron retorts do not, of course, last very long under such treatment. If the pipes are well washed on the inside with a thin paste of ocher and water and allowed to dry the gas and vapors passed through will not affect them much after the first charge.

The lime in the tubes is usually sufficient for two or three charges. It is better to renew it frequently, as it is gradually converted into calcium chloride, which melts on heating and when cooled requires to be washed out.

On a larger scale retorts similar in form to those used in making coal gas may be advantageously employed, the large delivery tube, partly filled with fragments of quicklime, being arranged so as to pass over the fire and be kept at a low red heat.

A RADIATING GAS-HEATING STOVE.

M. LEBRETON has invented a gas-heating stove, which he calls a thermo-condenser, and for which very considerable advantages are claimed. The apparatus may be used in conjunction with stoves consuming any kind of fuel, but it is of value chiefly when gas is employed, because it is intended to render available the greater part of the heat contained in the products of combustion. The stove consists of two parts, the lower being simply a combustion chamber, of no special design, while the upper portion, which is the thermo-condenser, consists of a number of tubes of thin copper, forming a multiple chimney. These tubes are made with projections or ornaments, intended to expedite the cooling of the smoke-vapors, and to greatly multiply the radiating surfaces. The inventor prefers to make the tubes spiky, similar to pine branches. With a stove of this construction M. Lebreton carries the condensation of the combustion gases to such a point that the condensed water contains most of the impurities which would otherwise be sent into the outer air. He claims to dispense with a chimney, and to preserve from contamination of burnt gases the air of the apartment heated by the stove. After heating for 9½ hours a room of about 80 cubic meters capacity, to a temperature of 20° to 21° C. (68° to 70° Fahr.), the outside temperature being 10° or 11° C (50° to 52° Fahr.), analysis of the air within showed only 7 parts in 10,000 of carbonic acid. The gas was consumed at the rate of 160 liters (5·6 cubic feet) per hour, or 1,550 liters (52 2 cubic feet) in all. The thermo-condenser was in constant use by M. Lebreton during last winter.

EVAPORATION OF GLYCERINE.

By M. G. COUTTOLENC.

IT is stated by many writers that, in the estimation of glycerine, when it is dissolved in a volatile vehicle, it may be determined by the simple evaporation of the substance at 100° to 110°, until the residue no longer loses any of its weight (or at least a very slight quantity, not exceeding 0 002 gramme in two hours).* Others, on the contrary, say that the dried extract, without glycerine, is obtained by evaporating at the same temperature for eight to ten hours.† These two statements appear to be slightly contradictory, and it seemed to me that it would be of interest to ascertain positively the volatility of glycerine at that temperature, or, better still, at a temperature slightly less (about 90°). For this purpose I used a water bath on which it was possible to place three capsules, to be heated by the steam.

The experiments consisted of three series:

1st. Evaporation of pure glycerine.

2d. The evaporation of glycerine with sand.

3d. The evaporation of glycerine whose volume had been augmented by repeated additions of water.

FIRST SERIES.—EVAPORATION OF PURE GLYCERINE.

In a tared capsule, 14·087 grammes of glycerine, having a density of 1·2424 at 16·75°, were placed.

During the first five hours of heating, there was a loss of 1·468 grammes, being 10·42 per cent. of the weight of glycerine. This large loss was partially due to the water which was contained in the sample of glycerine employed. Then, in the 41½ hours which followed, the capsule lost in weight 2 667 grammes, which was 21·13 per cent. of the weight of the glycerine supposed to have been dried by the first five hours heating, or 0·475 per cent. by hour. It is easy to see that in the above experiment the surface of evaporation is the most important factor to be considered, and it is impossible to obtain comparable results except when considered in relation to the surface. From this experiment it is concluded that the evaporation by square centimeter for the hour is equal to 0·00321 gramme.

A similar experiment, on a larger quantity of glycerine, gave during the first 5 hours a loss of 2·818 grammes on 30 712 grammes, which was equal to 9·18 per cent. During the following 23 hours there was a loss of 1·44 grammes, which, in relation to the weight, gives a loss considerably diminished, equivalent to 0·283 per cent. by hour, but which, when calculated in relation to the surface, gives for the evaporation to the square centimeter and by the hour 0·0313 gramme, a number sufficiently near the first.

The density of glycerine, after this evaporation, was 1 2624 at 15° (practically that of anhydrous glycerine).

SECOND SERIES.—EVAPORATION OF GLYCERINE WITH SAND.

2·687 grammes of glycerine were placed on 10 grammes of dry sand. During the first five hours of heating, the loss was 0 5495 gramme, equivalent to 20·14 per cent. of the weight taken.

In the 41½ hours which followed, the loss was 1·7315, which, when calculated to the weight of the glycerine dried during the first five hours of heating, equals 3·64 per cent. by the hour. This result is quite natural, as the sand does not increase the surface of evaporation.

THIRD SERIES.—EVAPORATION OF GLYCERINE WITH WATER.

In this series I endeavored to ascertain what effect was produced by the water in evaporating it simultaneously with glycerine. These experiments were repeated several times, but we give the results from one series only. In a capsule, A, 4·571 grammes of glycerine, with 10 c.c. of water, were placed, and in the dish, B, there were 4·974 grammes of glycerine with 5 c.c. of water. After being heated for 10 hours, the loss of A was 0·724 gramme, equivalent to 15·84 per cent., and for B 0·721 gramme, or 14·50 per cent.

It is well to recollect that the glycerine weighed was the same as that which lost 10 per cent. of its weight in the first experiment.

An additional 10 c.c. and 5 c.c were added, and after another 10 hours of heating the losses were 0·320 and 0·290 gramme, being 8·32 per cent. for A and 8·05 per cent for B.

* "Bulletin de la Soc. Chim.," XXXV., p. 659.

† "Agenda du Chimiste."

Again there was added water in the same proportions, the losses from which were 0·350 and 0·319 gramme, equal to 9·92 per cent. for A and 8·05 per cent. for B. Thus it is shown in the evaporation of water mixed with glycerine, that 5 c.c. of water carries off about 35 milligrammes of glycerine.

The density of glycerine after these evaporations was 1·2607 at 15·6°. The following conclusions may be obtained from the foregoing facts:

1. That aqueous glycerine loses its water after five hours heating over the water bath (at about 90°).

2. That the evaporation of glycerine continues in a regular manner at about the rate of 0·00317 gramme to the square centimeter of surface by hour.

3. That this evaporation rapidly diminishes with the lowering of the temperature.

4. The evaporation is in direct proportion to the surface, and is rapidly increased by the addition of sand.

5. The amount of water added to the glycerine produces variations in the evaporation in such a manner that, to a large quantity of water there is carried off a large quantity of glycerine, without there being any direct relation to the amount or volume of water added.

6. The exact determination of glycerine cannot be made desiccation at that temperature.—*Bull. de la Soc. Chim., Paris*, xxxvi, 133.

MISCELLANEOUS RECIPES.

BLEACHING BONES.—Dip the bones for a few moments in a boiling solution of one pound caustic soda in a gallon of water, then rinse thoroughly in water, rub down with fine pumice stone, and expose until whitened, to the vapor of burning sulphur largely diluted with air, then rinse in warm water. Bones may also be whitened by exposure in a weak solution of javelle water.

PORCELAIN ENAMEL FOR IRON.—Flint (quartz), calcined and ground, one hundred pounds; borax glass (anhydrous borax) ground, fifty pounds. Mix, fuse together in a crucible, and let it cool slowly. Powder and mix forty pounds of this glass with five pounds of kaolin (white potter's clay), and grind the mixture to a fine paste in water; pickle the vessel in dilute sulphuric acid, and scour with sand to thoroughly cleanse its surface; then line it with a coating of the above paste about one-sixth of an inch thick, and let it stand in a warm room until the coating has partially dried. Next dust over the surface of the paste coating (still moist) the following powder, and dry in an oven at 212° Fah.: White glass, free from lead or arsenic, one hundred and twenty-five pounds; borax, twenty-five pounds; carbonate of soda, fused, powdered, moistened with water and dried, twenty pounds. To forty-five pounds of this add one pound soda. Mix thoroughly with a little hot water, dry, and reduce to fine powder. When the coating on the iron has dried, the vessel is put in a muffle and the heat gradually increased until the glaze fuses, when it is taken out, more glaze powder is dusted on, and after a second heating allowed to cool very slowly. Some of the glazes employed consist of friable mixtures of feldspar, sodium carbonate, borax, and oxide of tin. Feldspar is also sometimes added to the enamel body.

HOW TO MAKE JAVELLE WATER.—Javelle water proper is prepared by passing gaseous chlorine—derived from the action of hot sulphuric acid on a mixture of common salt and oxide of manganese—into a ten-per-cent. aqueous solution of carbonate of potash until the latter will absorb no more. It may also be made by adding a solution of carbonate of potash to a solution of chlorinated lime (bleaching powder) as long as a precipitate continues to form, the liquid being afterward decanted or filtered. Ordinarily, however, the liquid called javelle water is chlorinated soda and not potassa. This liquid, also known as Labarraque's disinfectant, is prepared by dissolving 12 oz. (avoir.) of soda crystals in 1 quart (imperial), and saturate with chlorine gas evolved from 1 oz. of black oxide of manganese, 4 oz. common salt, and 2½ fl. oz. of sulphuric acid diluted with 3 fl. oz. of water by aid of heat in a retort. A readier way of making the solution for ordinary purposes consists in making a solution of ½ lb. good lime chloride in 3 pints of water with 7 oz. carbonate of soda (crystals) in 1 pint of water—drawing off the clear liquid after the mixture has settled. Glauber salt (sulphate of soda) may be used instead of part of the carbonate; with this the proportion may be 5 lb. bleaching powder, 10 lb. sulphate of soda, 4 lb. sal soda, and 4 pails of water, well mixed. Sulphate of lime deposits from this liquid.

MECHANICAL DEVICES FOR FACILITATING THE GATHERING OF THE COTTON CROP.

A CAREFUL study of a late liberally-illustrated article in the SCIENTIFIC AMERICAN, on the above subject, prompts me to write down some of my own thoughts upon it. There is great need for the improvements contemplated by the inventors of those machines. The chief obstacle to full success, and one that was noticed in your article, is the unequal maturing of the crop. In this latitude—central Alabama—the first cotton is ready to be picked late in August; the last, if the army worm stays away, from the 1st of November to the 15th of December, according to the fall of severe frosts. If cotton be not picked soon after the opening of the pods, it is liable to injury from various agents. Every fall of rain beats some of it out of the pods or bolls, and washes away from it the oil that imparts to it a rich complexion, substituting therefor a sooty white; long exposure to the air makes the fiber more brittle, and thereby more liable to be broken in the process of ginning or extraction of the seed, besides mixing with the fibers small particles of dried leaves, sand, and clay.

The first bolls are always on the lower limbs, and on that portion of them nearest to the central stem or stalk, so that the first picking is the most laborious and troublesome. As the season advances the opened bolls are further and further away from the central stalk, and higher and higher from the ground. It not uncommonly happens, when the season for growth and maturity is prolonged by the late coming of frosts, that a considerable proportion of bolls are caught in an immature state. Sometimes these do not open at all, but form a fair article of food for cows in winter. More often, after the lapse of weeks, they open somewhat, and the cotton picked from them, though good, is decidedly inferior to that fully matured before frost. But necessarily these half-opened bolls are difficult to be picked, and many a machine would be of little avail upon them, that would gather with facility the protruding locks of the fully opened bolls. This inferior, ill-matured cotton sometimes constitutes one fourth of the whole crop. After much thought I am convinced that no machinery yet devised can accomplish all that is now accomplished by hand. Yet such machines are not therefore useless, for where the crop is a full one, where the progress through the whole season of growth has been steady, so much cotton is open at one time that every minor objection may be rightly disregarded, and such appliances be resorted to as will insure the greatest gathering in the shortest time after the first killing frosts.

But, after all, I am satisfied that inventive talent in this matter ought to take a new departure, and in a direction which I can perhaps make more manifest by giving some details of my own experience as a cotton planter before the war. In central Alabama we used to be satisfied if our best hands gathered each day two hundred pounds of seed cotton. Exceptionally good hands would do more, picking every day, from the middle of September, three hundred pounds.

Selling my lands in Alabama, I moved West and settled in the Mississippi bottom, though not on the bank of that mighty stream. I was amazed to hear my neighbors talk of hands that picked five, six, and even eight hundred pounds of cotton in a day. I very soon found out, however, that such figures were reached by methods essentially different from those pursued by me and my neighbors in Alabama. My negroes termed it, not cotton-picking, but boll-gathering. The common method of picking cotton, and the one contemplated by all the designers of the machines illustrated in that number of the SCIENTIFIC AMERICAN alluded to above, is to pluck the fiber from the pod, leaving the pod on the stalk. The western plan, although professedly the same, was, in truth, little more than gathering both pod and fiber, leaving largely to improved gins the task of separating the cotton and pods during the process of extracting the seed from the fiber. After much thought I have long been convinced that the paths of advance in this matter lie in an intensification, so to speak, of the Western method—abandoning all attempts to pick cotton from the bolls in the field, and devising machines for plucking with rapidity the opened bolls with all their contents. Instead of introducing this mixture of pod and cotton directly to the gin, there should be a machine for separating it in the gin-house. I am convinced that the American inventors who have effected such marvels in the matter of extracting the cotton from the bolls in the field, can easily devise very efficient machines for separating, at a trivial cost, pod and cotton in the house. I am also thoroughly satisfied, from long thought of the matter, and perfect familiarity with all details of the cotton crop, that machinery for gathering mature bolls—pod and contents—can be devised that will far outstrip any possible boll-gathering by hand. What is wanted then is,

First, an improved boll-gatherer, to be used in the fields through the whole season.

Second, an improved separator of pods and cotton.

This last might, no doubt, be combined with or form a part of the gins now in use for separating fiber from motes, seed, and dirt.

J. A. GOREE.

RAPID TREE GROWTHS.

ACCORDING to a report of the Horticultural Society of Madras two trees in the Botanical Garden there display the marvelous rapidity of tree-growths in tropical countries. The rain-tree (*Pithecolobium saman*) in the gardens, the measurements of which were given in the proceedings of the society 7th of August, 1878, and then believed to be under six years from the seed, continues, in spite of its having been necessary to amputate some of the largest limbs, to grow enormously. Measured on the 30th of July last it gave in girth nine feet four inches at the ground, six feet three inches at three feet high, and five feet nine inches at five feet high; in spread about eighty-five feet from north to south, and a total height of about forty-six feet. A reference to the former measurements shows that the girth at three feet from the ground has increased in the last three years two feet two inches. The age of the tree is, if anything, overestimated; but search is being made for traces of the receipt of the seed, which it is believed came from Ceylon about 1872. A casuarina tree, standing alongside, which was the specimen of its order when that part of the ground was laid out at the Botanical Garden, and is therefore known to be about ten years old, now measures at five feet from the ground, only two feet eight and a half inches, though it is about eighty-two feet high.

THE LENGTH OF LIFE OF BUTTERFLIES.*

By W. H EDWARDS.

SOME inquiries on the subject led me to investigate the matter, and to refer to my note books, in which are recorded everything that has come under my observation relating to butterflies for the past fifteen years.

Boisduval, and Kirby, and Spence allege that the life of the summer butterflies is brief, the male expiring soon after copulation, the female after oviposition. On the other hand, Mr. Scudder has spoken of butterflies living two to three months. Mr. Edwards expressed the opinion as to the hibernating butterflies, that they lived from about the first of September to the end of the following May, or eight to nine months at the outside. Whereas Mr. Scudder asserts that *D. archippus* lives from a year to fifteen or sixteen months.

Observations show that one brood follows another in rapid succession in many species at the South, a month sufficing for the complete duration of the generation. As the emergence of individuals from the chrysalis is not all at once, but is continued through several days or weeks, it follows that the life of any individual butterfly must be much less than the duration of its generation; certainly not over one half to two-thirds that of the generation. In the case of polymorphic species like *Papilio ajax*, it is not difficult to fix the duration with some definiteness. Mr. Edwards gave from his note books dates of the first and last appearance at Coalburgh, W. Va., of the form *Ajax walshii* and of the form *Ajax telamonides*, and showed that an individual life could hardly be more than two to three weeks. It was stated that not only in this species but in most or all which had come under observation, it is the old males which mate with the young female as soon, or nearly as soon, as she emerges from the chrysalis. These old males are on the watch, flying about everywhere, and seize the young female, often before her wings are dry, and hence before the young male, if emerging at the same time with the female, would be strong enough to take part in the copulation. Consequently it happens that many of the males are unable to find mates, and these males are the longest lived. The last butterflies of the generation are often seen to be old males, who probably have never mated.

Similar conclusions as to the duration of life were drawn from observations on the polymorphic species, *Lycæna pseudargiolus*, of which *L. violacea* is the early form.

For an example of the hibernating species, the history of *D. archippus* was detailed. It is three or four brooded in West Virginia; the old females die in May, after laying their eggs. These eggs produce the first generation of butterflies of the year, and the females of this lay eggs which produce the second generation, and so on to the end. The eggs are always laid by females plainly not long from the chrysalis. We have carefully watched this species all through the year 1878, and had given the results as briefly stated here in *Psyche*, Dec., 1878. This was because Mr. Scudder, in *Psyche*, July, 1875, had represented Archippus as having habits unlike any other butterfly, in that it was single-brooded over North America, and not double-brooded; that it left its winter quarters late, and continued on the wing the rest of the season, laying eggs all the time, so that the caterpillars to be found all along through the season were produced by its eggs, *instead of coming from the eggs of young females*. The young females, in fact, could not lay until they had passed hibernation. It will be seen that such behavior involves a radical change of habits of the race, wherein this butterfly, laying eggs at intervals for months, approaches the mammals.

Mr. Scudder recently repeats this story in his "Butterflies," 1881, without note or comment or any additional data, or any verification at all, and hence Mr. Edwards' paper.

* Abstract of a paper read at the Cincinnati Meeting of the American Association for Advancement of Science.

A CATALOGUE, containing brief notices of many important scientific papers heretofore published in the SUPPLEMENT, may be had gratis at this office.

THE
Scientific American Supplement.
PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $3.50, stitched in paper, or $3.50, bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,

37 Park Row, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. ENGINEERING AND MECHANICS.—What to Do when the Locomotive Breaks Down. By FRANK C. SMITH.... 5009
Advance in the Price of Locomotives.... 5009
Refrigerating Apparatus.—Steamships Strathlevin and Dunedin.—4 figures.—Refrigerating machine for cooling ships' provisions, and plans showing the arrangement of apparatus on shipboard.... 5001
The New Dry Docks at the Erie Basin.... 5002
Machine for Beating Fabrics. 2 figures.... 5002
Apparatus for Drying Pasteboard. 4 figures.... 5003
Mechanical Devices for Facilitating the Gathering of the Cotton Crop.... 5004

II. TECHNOLOGY AND CHEMISTRY.—A New Gas Kiln.... 5011
Largillière's Apparatus for Continuous Diffusion. 2 figures.... 5012
Union by Pressure.... 5012
Our Sweets—Various sources of commercial sugar.... 5012
Apparatus for Treating Wood with Ozonized Oxygen. 1 figure.... 5013
Oxygen from Bleaching Powder. 1 figure.... 5013
A Radiating Gas-heating Stove.... 5013
Evaporation of Glycerine. By M. G. COUTTOLENC.... 5013

III. ELECTRICITY, ETC.—Secondary Batteries.—On Grove's, Plante's, and Faure's secondary batteries. By Prof. W. GRYLLS ADAMS.—A valuable statement of the construction, operation, efficiency, and utility of the new reservoirs of electrical energy.... 5003
Magnet Dynamometer. By Prof. ANTONIO COSTA SAVA. 4 figures.—Experiments.—Magnetic repulsion.—Distribution of magnetism in magnets.—Electric Dynamometer, etc.... 5004
Improved Dynamometer. 1 figure.—Smith's dynamometer.... 5005
Effects of Telegraph Wires on Animals.... 5005
Electric Lighting.—Report of Franklin Institute Committee.... 5005
The Swan system of Electric Lighting. 6 figures.—Mr. Swan's electro-chemical shop at Newcastle.—A street in Newcastle lighted by swan lamps.—Lamps.—Stands.—Connections, etc.... 5006

IV. MEDICINE, HYGIENE, ETC.—Digestion and the Use of Artificial Digestive Agents. By J. MILNER FOTHERGILL.—1 diagram of the digestive tract.... 5010
Pilocarpin in Diphtheria.... 5010
The Treatment of Smallpox.... 5011
Fresh Air for Scarlet Fever.... 5011
The Resemblances and Differences of the Two Sexes. By M. G. DELAUNAY.... 5011

V. ARCHITECTURE, ARCHÆOLOGY, ETC.—The Temple of the Sun, Baalbek. 1 illustration.... 5009
Suggestions in Decorative Art. 1 illustration.—Iron screen, designed by WALTER LANE.... 5008
The Gallery of Victor Emmanuel at Milan. Full page illustration.... 5008

VI. PHYSICS, ETC.—Lunar Disturbances of the Earth's Gravity.... 5007
Earth Tremors from Small Stresses and from Lunar Disturbances.... 5007
Compass Surveying. By Prof. FRANCIS E. NIPHER.... 5008

VII. NATURAL HISTORY.—Rapid Tree Growths.... 5014
The Length of Life of Butterflies. By W. H. EDWARDS.... 5014

VIII. OBITUARY.—James Clerk Maxwell. Portrait.... 4009

IX. MISCELLANEOUS.—Recipes. Bleaching Bones.—Porcelain enamel for Iron. How to Make Javelle Water.... 5014

PATENTS.

In connection with the **Scientific American**, Messrs. MUNN & Co. are Solicitors of American and Foreign Patents, have had 35 years' experience, and now have the largest establishment in the world. Patents are obtained on the best terms.

A special notice is made in the **Scientific American** of all Inventions patented through this Agency, with the name and residence of the Patentee. By the immense circulation thus given, public attention is directed to the merits of the new patent, and sales or introduction often easily effected.

Any person who has made a new discovery or invention can ascertain, free of charge, whether a patent can probably be obtained, by writing to MUNN & Co.

We also send free our Hand Book about the Patent Laws, Patents, Caveats, Trade Marks, their costs, and how procured, with hints for procuring advances on inventions. Address

MUNN & CO., 37 Park Row, New York.
Branch Office, cor. F and 7th Sts., Washington, D. C.